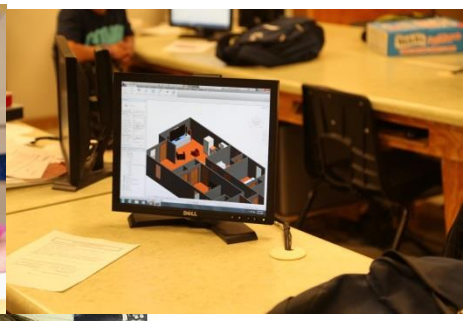
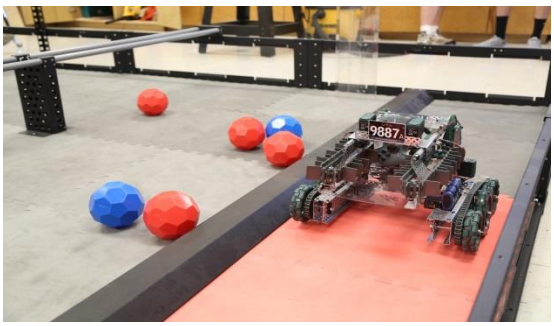
SUPPORT GUIDE
FOR GRADE SEVEN
SOUTH CAROLINA ACADEMIC STANDARDS AND PERFORMANCE INDICATORS
FOR SCIENCE


Molly M. Spearman
State Superintendent of Education

South Carolina Department of Education
Columbia, South Carolina

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INTRODUCTION TO GRADE SEVEN STANDARDS

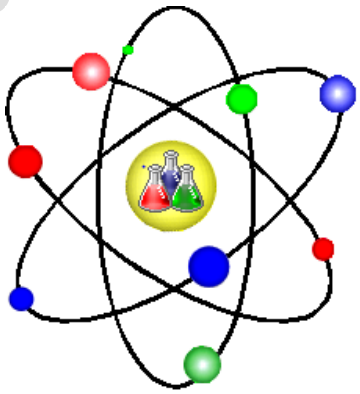
Science is a way of understanding the physical universe using observation and experimentation to explain natural phenomena. Science also refers to an organized body of knowledge that includes core ideas to the disciplines and common themes that bridge the disciplines. This document, *South Carolina Academic Standards and Performance Indicators for Science*, contains the academic standards in science for the state's students in kindergarten through grade twelve.

ACADEMIC STANDARDS

In accordance with the South Carolina Education Accountability Act of 1998 (S.C. Code Ann. § 59-18-110), the purpose of academic standards is to provide the basis for the development of local curricula and statewide assessment. Consensually developed academic standards describe for each grade and high school core area the specific areas of student learning that are considered the most important for proficiency in the discipline at the particular level.

Operating procedures for the review and revision of all South Carolina academic standards were jointly developed by staff at the State Department of Education (SCDE) and the Education Oversight Committee (EOC). According to these procedures, a field review of the first draft of the revised South Carolina science standards was conducted from March through May 2013. Feedback from that review and input from the SCDE and EOC review panels was considered and used to develop these standards.

The academic standards in this document are not sequenced for instruction and do not prescribe classroom activities; materials; or instructional strategies, approaches, or practices. The *South Carolina Academic Standards and Performance Indicators for Science* is not a curriculum.



THE PROFILE OF THE SOUTH CAROLINA GRADUATE

The *2014 South Carolina Academic Standards and Performance Indicators for Science* support the *Profile of the South Carolina Graduate. The Profile of the South Carolina Graduate* has been adopted and approved by the South Carolina Association of School Administrators (SCASA), the South Carolina Chamber of Commerce, the South Carolina Council on Competitiveness, the Education Oversight Committee (EOC), the State Board of Education (SBE), and the South Carolina Department of Education (SCDE) in an effort to identify the knowledge, skills, and characteristics a high school graduate should possess in order to be prepared for success as they enter college or pursue a career. The profile is intended to guide all that is done in support of college- and career-readiness.

Profile of the South Carolina Graduate

World Class Knowledge

- Rigorous standards in language arts and math for career and college readiness
- Multiple languages, science, technology, engineering, mathematics (STEM), arts and social sciences

World Class Skills

- Creativity and innovation
- Critical thinking and problem solving
- Collaboration and teamwork
- Communication, information, media and technology
- Knowing how to learn

Life and Career Characteristics

- Integrity
- Self-direction
- Global perspective
- Perseverance
- Work ethic
- Interpersonal skills

Approved by SCASA Superintendent's Roundtable and SC Chamber of Commerce.

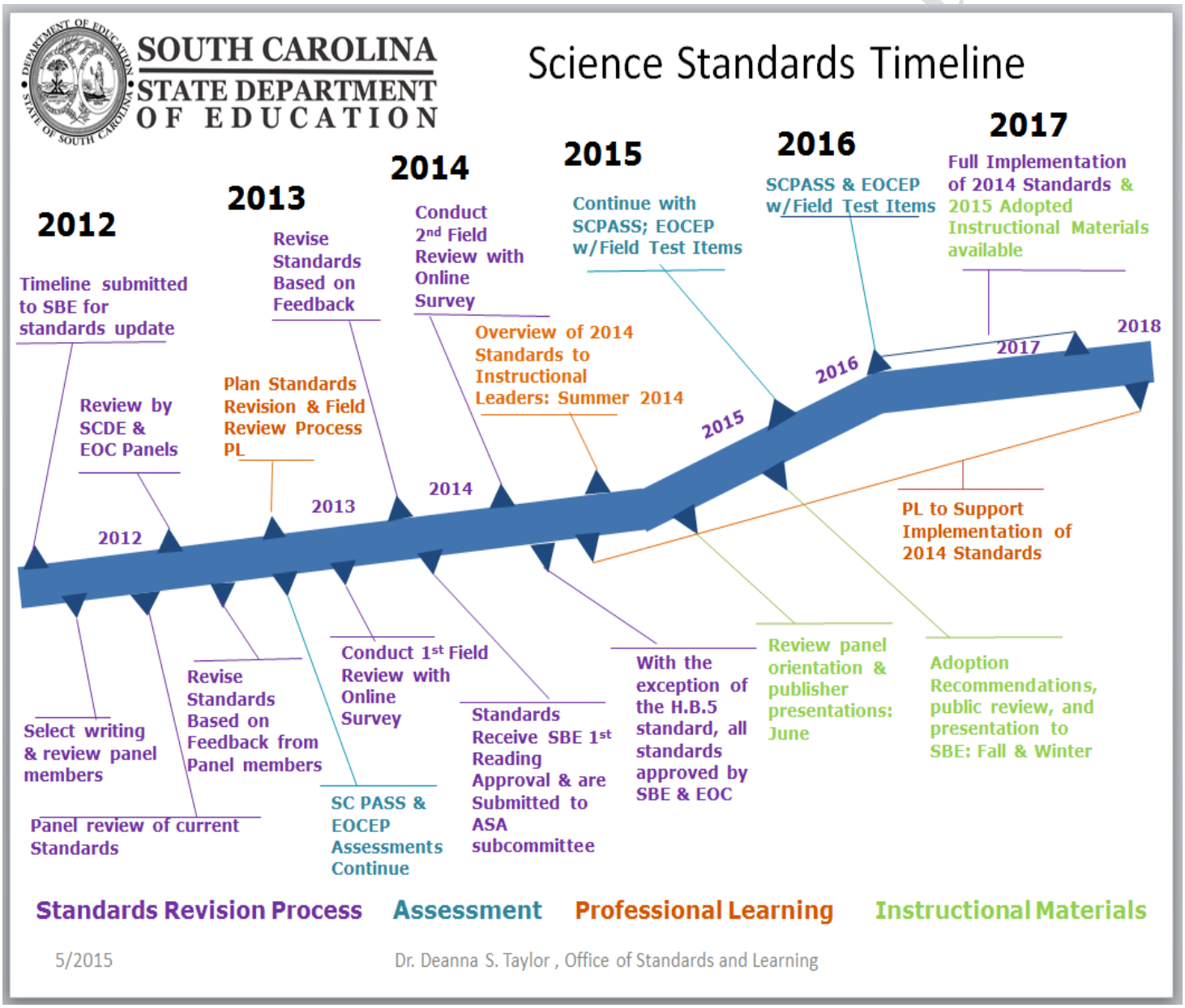
transformSC
tomorrow won't wait for our students

AN INITIATIVE OF SOUTH CAROLINA COUNCIL ON COMPETITIVENESS

SCIENCE STANDARDS TIMELINE

This timeline is used to illustrate the timeline for the standards revisions process, student assessment administration, provision of professional learning and the review and adoption of instructional materials. This timeline may be used with the science academic standards, science and engineering support document, and grade/content support documents to assist local districts, schools and teachers as they construct standards-based science curriculum, allowing them to add or expand topics they feel are important and to organize content to fit their students' needs and match available instructional materials.

The timeline in this document does not offer a sequence for instruction and do not prescribe classroom activities; materials; or instructional strategies, approaches, or practices. The *Science Standards Timeline*, is not a curriculum.



CROSSCUTTING CONCEPTS

Seven common threads or themes are presented in *A Framework for K-12 Science Education* (2012). These concepts connect knowledge across the science disciplines (biology, chemistry, physics, earth and space science) and have value to both scientists and engineers because they identify universal properties and processes found in all disciplines. These crosscutting concepts are:

1. Patterns
2. Cause and Effect: Mechanism and Explanation
3. Scale, Proportion, and Quantity
4. Systems and System Models
5. Energy and Matter: Flows, Cycles, and Conservation
6. Structure and Function
7. Stability and Change

These concepts should not to be taught in isolation but reinforced in the context of instruction within the core science content for each grade level or course.

SCIENCE AND ENGINEERING PRACTICES

In addition to the academic standards, each grade level or high school course explicitly identifies S*cience and Engineering Practice* standards, with indicators that are differentiated across grade levels and core areas. The term "practice" is used instead of the term "skill," to emphasize that scientists and engineers use skill and knowledge simultaneously, not in isolation. These eight science and engineering practices are:

1. Ask questions and define problems
2. Develop and use models
3. Plan and conduct investigations
4. Analyze and interpret data
5. Use mathematical and computational thinking
6. Construct explanations and design solutions
7. Engage in scientific argument from evidence
8. Obtain, evaluate, and communicate information

Students should engage in scientific and engineering practices as a means to learn about the specific topics identified for their grade levels and courses. It is critical that educators understand that the Science and Engineering Practices are *not* to be taught in isolation. There should *not* be a distinct "Inquiry" unit at the beginning of each school year. Rather, the practices need to be employed *within the content* for each grade level or course.

Additionally, an important component of all scientists and engineers' work is communicating their results both by informal and formal speaking and listening, and formal reading and writing. Speaking, listening, reading and writing is important not only for the purpose of sharing results, but because during the processes of reading, speaking, listening and writing, scientists and engineers continue to construct their own knowledge and understanding of meaning and implications of their research. Knowing how one's results connect to previous results and what those connections reveal about the underlying principles is an important part of the scientific discovery process. Therefore, students should similarly be reading, writing, speaking and listening throughout the scientific processes in which they engage.

For additional information regarding the development, use and assessment of the *2014 Academic Standards and Performance Indicators for Science* please see the official document that is posted on the SCDE science web page--- http://tinyurl.com/2014SCScience.

DECIPHERING THE STANDARDS

KINDERGARTEN

LIFE SCIENCE: EXPLORING ORGANISMS AND THE ENVIRONMENT

Standard K.L.2: The student will demonstrate an understanding of organisms found in the environment and how these organisms depend on the environment to meet those needs.

K.L.2A. Conceptual Understanding: The environment consists of many types of organisms including plants, animals, and fungi. Organisms depend on the land, water, and air to live and grow. Plants need water and light to make their own food. Fungi and animals cannot make their own food and get energy from other sources. Animals (including humans) use different body parts to obtain food and other resources needed to grow and survive. Organisms live in areas where their needs for air, water, nutrients, and shelter are met.

Performance Indicators: Students who demonstrate this understanding can:

K.L.2A.1 Obtain information to answer questions about different organisms found in the environment (such as plants, animals, or fungi).

K.L.2A.2 Conduct structured investigations to determine what plants need to live and grow (including water and light).

Figure 1: Example from the Kindergarten Standards

The code assigned to each performance indicator within the standards is designed to provide information about the content of the indicator. For example, the **K.L.2A.1** indicator decodes as the following--

- **K: The first part of each indicator denotes the grade or subject.** The example indicator is from Kindergarten. The key for grade levels are as follows—

  K: Kindergarten
  1: First Grade
  2: Second Grade
  3: Third Grade
  4: Fourth Grade
  5: Fifth Grade
  6: Sixth Grade
  7: Seventh Grade
  8: Eighth Grade
  H.B: High School Biology 1
  H.C: High School Chemistry 1
  H.P: High School Physics 1
  H.E: High School Earth Science

- **L: After the grade or subject, the content area is denoted by an uppercase letter.** The L in the example indicator means that the content covers Life Science. The key for content areas are as follows—
  - E: Earth Science
  - EC: Ecology
  - L: Life Science
  - P: Physical Science
  - S: Science and Engineering Practices

- **2: The number following the content area denotes the specific academic standard.** In the example, the 2 in the indicator means that it is within the second academic standard with the Kindergarten science content.

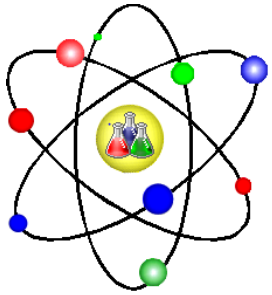
- **A: After the specific content standard, the conceptual understanding is denoted by an uppercase letter.** The conceptual understanding is a statement of the core idea for which students should demonstrate understanding. There may be more than one conceptual understanding per academic standard. The A in the example means that this is the first conceptual understanding for the standard. Additionally, the conceptual understandings are novel to the *2014 South Carolina Academic Standards and Performance Indicators for Science*.

- **1: The last part of the code denotes the number of the specific performance indicator.** Performance indicators are statements of what students can do to demonstrate knowledge of the conceptual understanding. The example discussed is the first performance indicator within the conceptual understanding.

Core Areas of Grade Seven Science Standards

The four core areas of the grade seven standards include:

- Classification and Conservation of Matter
- Organization in Living Systems
- Heredity – Inheritance and Variation of Traits
- Interactions of Living Systems and the Environment



GRADE SEVEN
SCIENCE AND ENGINEERING PRACTICES

NOTE: Scientific investigations should always be done in the context of content knowledge expected in this course. The standard describes how students should learn and demonstrate knowledge of the content outlined in the other standards.

Standard 7.S.1: The student will use the science and engineering practices, including the processes and skills of scientific inquiry, to develop understandings of science content.

7.S.1A. Conceptual Understanding: The practices of science and engineering support the development of science concepts, develop the habits of mind that are necessary for scientific thinking, and allow students to engage in science in ways that are similar to those used by scientists and engineers.

Performance Indicators: Students who demonstrate this understanding can:

7.S.1A.1 Ask questions to (1) generate hypotheses for scientific investigations, (2) refine models, explanations, or designs, or (3) extend the results of investigations or challenge claims.

7.S.1A.2 Develop, use, and refine models to (1) understand or represent phenomena, processes, and relationships, (2) test devices or solutions, or (3) communicate ideas to others.

7.S.1A.3 Plan and conduct controlled scientific investigation to answer questions, test hypotheses, and develop explanations: (1) formulate scientific questions and testable hypotheses, (2) identify materials, procedures, and variables, (3) select and use appropriate tools or instruments to collect qualitative and quantitative data, and (4) record and represent data in an appropriate form. Use appropriate safety procedures.

7.S.1A.4. Analyze and interpret data from informational texts, observations, measurements, or investigations using a range of methods (such as tabulation, graphing, or statistical analysis) to (1) reveal patterns and construct meaning or (2) support hypotheses, explanations, claims, or designs.

7.S.1A.5 Use mathematical and computational thinking to (1) use and manipulate appropriate metric units, (2) collect and analyze data, (3) express relationships between variables for models and investigations, or (4) use grade-level appropriate statistics to analyze data.

7.S.1A.6 Construct explanations of phenomena using (1) primary or secondary scientific evidence and models, (2) conclusions from scientific investigations, (3) predictions based on observations and measurements, or (4) data communicated in graphs, tables, or diagrams.

7.S.1A.7 Construct and analyze scientific arguments to support claims, explanations, or designs using evidence from observations, data, or informational texts.

SCIENCE AND ENGINEERING PRACTICES *(CONTINUED)*

7.S.1A.8 Obtain and evaluate scientific information to (1) answer questions, (2) explain or describe phenomena, (3) develop models, (4) evaluate hypotheses, explanations, claims, or designs or (5) identify and/or fill gaps in knowledge. Communicate using the conventions and expectations of scientific writing or oral presentations by (1) evaluating grade-appropriate primary or secondary scientific literature, or (2) reporting the results of student experimental investigations.

7.S.1B. Conceptual Understanding: Technology is any modification to the natural world created to fulfill the wants and needs of humans. The engineering design process involves a series of iterative steps used to solve a problem and often leads to the development of a new or improved technology.

Performance Indicators: Students who demonstrate this understanding can:

7.S.1B.1 Construct devices or design solutions using scientific knowledge to solve specific problems or needs: (1) ask questions to identify problems or needs, (2) ask questions about the criteria and constraints of the device or solutions, (3) generate and communicate ideas for possible devices or solutions, (4) build and test devices or solutions, (5) determine if the devices or solutions solved the problem and refine the design if needed, and (6) communicate the results.

PHYSICAL SCIENCE: CLASSIFICATION AND CONSERVATION OF MATTER

Standard 7.P.2: The student will demonstrate an understanding of the structure and properties of matter and that matter is conserved as it undergoes changes.

7.P.2A. Conceptual Understanding: All substances are composed of one or more elements. Elements are pure substances which contain only one kind of atom. The periodic table organizes these elements based on similar properties. Compounds are substances composed of two or more elements. Chemical formulas can be used to describe compounds.

Performance Indicators: Students who demonstrate this understanding can:

7.P.2A.1 Develop and use simple atomic models to illustrate the components of elements (including the relative position and charge of protons, neutrons, and electrons).

7.P.2A.2 Obtain and use information about elements (including chemical symbol, atomic number, atomic mass, and group or family) to describe the organization of the periodic table.

7.P.2A.3 Analyze and interpret data to describe and classify matter as pure substances (elements or compounds) or mixtures (heterogeneous or homogeneous) based on composition.

7.P.2A.4 Construct explanations for how compounds are classified as ionic (metal bonded to nonmetal) or covalent (nonmetals bonded together) using chemical formulas.

7.P.2B.1 Analyze and interpret data to describe substances using physical properties (including state, boiling/melting point, density, conductivity, color, hardness, and magnetic properties) and chemical properties (the ability to burn or rust).

PHYSICAL SCIENCE: CLASSIFICATION AND CONSERVATION OF MATTER *(CONTINUED)*

7.P.2B. Conceptual Understanding: Substances (such as metals or acids) are identified according to their physical or chemical properties. Changes to substances can either be physical or chemical. Many substances react chemically with other substances to form new substances with different properties. According to the law of conservation of matter, total mass does not change in a chemical reaction.

7.P.2B.2 Use mathematical and computational thinking to describe the relationship between the mass, volume, and density of a given substance.

7.P.2B.3 Analyze and interpret data to compare the physical properties, chemical properties (neutralization to form a salt, reaction with metals), and pH of various solutions and classify solutions as acids or bases.

7.P.2B.4 Plan and conduct controlled scientific investigations to answer questions about how physical and chemical changes affect the properties of different substances.

7.P.2B.5 Develop and use models to explain how chemical reactions are supported by the law of conservation of matter.

LIFE SCIENCE: ORGANIZATION IN LIVING SYSTEMS

Standard 7.L.3: The student will demonstrate an understanding of how the levels of organization within organisms support the essential functions of life.

7.L.3A. Conceptual Understanding: Cells are the most basic unit of any living organism. All organisms are composed of one (unicellular) or many cells (multicellular) and require food and water, a way to dispose of waste, and an environment in which they can live in order to survive. Through the use of technology, scientists have discovered special structures within individual cells that have specific functions that allow the cell to grow, survive, and reproduce. Bacteria are one-celled organisms found almost everywhere and can be both helpful and harmful. They can be simply classified by their size, shape and whether or not they can move.

Performance Indicators: Students who demonstrate this understanding can:

7.L.3A.1 Obtain and communicate information to support claims that (1) organisms are made of one or more cells, (2) cells are the basic unit of structure and function of organisms, and (3) cells come only from existing cells.

7.L.3A.2 Analyze and interpret data from observations to describe different types of cells and classify cells as plant, animal, protist, or bacteria.

7.L.3A.3 Develop and use models to explain how the relevant structures within cells (including cytoplasm, cell membrane, cell wall, nucleus, mitochondria, chloroplasts, lysosomes, and vacuoles) function to support the life of plant, animal, and bacterial cells.

7.L.3A.4 Construct scientific arguments to support claims that bacteria are both helpful and harmful to other organisms and the environment.

LIFE SCIENCE: ORGANIZATION IN LIVING SYSTEMS *CONTINUED)*

7.L.3B. Conceptual Understanding: Multicellular organisms (including humans) are complex systems with specialized cells that perform specific functions. Organs and organ systems are composed of cells that function to serve the needs of cells which in turn serve the needs of the organism.

Performance Indicators: Students who demonstrate this understanding can:

7.L.3B.1 Develop and use models to explain how the structural organizations within multicellular organisms function to serve the needs of the organism.

7.L.3B.2 Construct explanations for how systems in the human body (including circulatory, respiratory, digestive, excretory, nervous, and musculoskeletal systems) work together to support the essential life functions of the body.

LIFE SCIENCE: HEREDITY – INHERITANCE AND VARIATION OF TRAITS

Standard 7.L.4: The student will demonstrate an understanding of how genetic information is transferred from parent to offspring and how environmental factors and the use of technologies influence the transfer of genetic information.

7.L.4A. Conceptual Understanding: Inheritance is the key process causing similarities between parental organisms and their offspring. Organisms that reproduce sexually transfer genetic information (DNA) to their offspring. This transfer of genetic information through inheritance leads to greater similarity among individuals within a population than between populations. Technology allows humans to influence the transfer of genetic information.

Performance Indicators: Students who demonstrate this understanding can:

7.L.4A.1 Obtain and communicate information about the relationship between genes and chromosomes to construct explanations of their relationship to inherited characteristics.

7.L.4A.2 Construct explanations for how genetic information is transferred from parent to offspring in organisms that reproduce sexually.

7.L.4A.3 Develop and use models (Punnett squares) to describe and predict patterns of the inheritance of single genetic traits from parent to offspring (including dominant and recessive traits, incomplete dominance, and codominance).

7.L.4A.4 Use mathematical and computational thinking to predict the probability of phenotypes and genotypes based on patterns of inheritance.

7.L.4A.5 Construct scientific arguments using evidence to support claims for how changes in genes (mutations) may have beneficial, harmful, or neutral effects on organisms.

7.L.4A.6 Construct scientific arguments using evidence to support claims concerning the advantages and disadvantages of the use of technology (such as selective breeding, genetic engineering, or biomedical research) in influencing the transfer of genetic information.

ECOLOGY: INTERACTIONS OF LIVING SYSTEMS AND THE ENVIRONMENT

Standard 7.EC.5: The student will demonstrate an understanding of how organisms interact with and respond to the biotic and abiotic components of their environments.

7.EC.5A. Conceptual Understanding: In all ecosystems, organisms and populations of organisms depend on their environmental interactions with other living things (biotic factors) and with physical (abiotic) factors (such as light, temperature, water, or soil quality). Disruptions to any component of an ecosystem can lead to shifts in its diversity and abundance of populations.

Performance Indicators: Students who demonstrate this understanding can:

7.EC.5A.1 Develop and use models to describe the characteristics of the levels of organization within ecosystems (including species, populations, communities, ecosystems, and biomes).

ECOLOGY: INTERACTIONS OF LIVING SYSTEMS AND THE ENVIRONMENT *(CONTINUE)*

7.EC.5A.2 Construct explanations of how soil quality (including composition, texture, particle size, permeability, and pH) affects the characteristics of an ecosystem using evidence from soil profiles.

7.EC.5A.3 Analyze and interpret data to predict changes in the number of organisms within a population when certain changes occur to the physical environment (such as changes due to natural hazards or limiting factors).

7.EC.5B. Conceptual Understanding: Organisms in all ecosystems interact with and depend upon each other. Organisms with similar needs compete for limited resources. Food webs and energy pyramids are models that demonstrate how energy is transferred within an ecosystem.

Performance Indicators: Students who demonstrate this understanding can:

7.EC.5B.1 Develop and use models to explain how organisms interact in a competitive or mutually beneficial relationship for food, shelter, or space (including competition, mutualism, commensalism, parasitism, and predator-prey relationships).

7.EC.5B.2 Develop and use models (food webs and energy pyramids) to exemplify how the transfer of energy in an ecosystem supports the concept that energy is conserved.

7.EC.5B.3 Analyze and interpret data to predict how changes in the number of organisms of one species affects the balance of an ecosystem.

7.EC.5B.4 Define problems caused by the introduction of a new species in an environment and design devices or solutions to minimize the impact(s) to the balance of an ecosystem.

GRADE 7 CROSSWALK
FOR THE 2005 SOUTH CAROLINA SCIENCE ACADEMIC STANDARDS AND THE 2014 SOUTH CAROLINA ACADEMIC STANDARDS AND PERFORMANCE INDICATORS FOR SCIENCE

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ACKNOWLEDGEMENTS

SOUTH CAROLINA DEPARTMENT OF EDUCATION

The *Crosswalks for the South Carolina Academic Standards and Performance Indicators for Science* included in this document were developed under the direction of Dr. Julie Fowler, Deputy Superintendent, Division of College and Career Readiness and Cathy Jones Stork, Interim Director, Office of Standards and Learning.

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INTRODUCTION

This document, *Crosswalks for the 2005 South Carolina Science Academic Standards and the 2014 South Carolina Academic Standards and Performance Indicators for Science,* contains a comparison of the academic standards in science for the state's students in kindergarten through grade twelve.

HOW TO USE THE CROSSWALKS

This document may be used with the science academic standards, science and engineering support document, and grade/content support documents to assist local districts, schools and teachers as they construct standards-based science curriculum, allowing them to add or expand topics they feel are important and to organize content to fit their students' needs and match available instructional materials. 2005 and 2014 performance indicators that share similar content knowledge and skills that students should demonstrate to meet the grade level or high school course standards have been paired. These pairings have been organized into tables and are sequenced by the 2014 academic standards. The 2005 content indicators that do not match 2014 content have been placed at the end of each table. Additionally, since the conceptual understandings are novel to the *2014 South Carolina Academic Standards and Performance Indicators for Science* these portions of the crosswalk to not correlate to the *2005 South Carolina Science Academic Standards*. Conceptual understandings are statements of the core ideas for which students should demonstrate an understanding. Some grade level topics include more than one conceptual understanding with each building upon the intent of the standard.

The academic standards in this document are not sequenced for instruction and do not prescribe classroom activities; materials; or instructional strategies, approaches, or practices. The *Crosswalks for the 2005 South Carolina Science Academic Standards and the 2014 South Carolina Academic Standards and Performance Indicators for Science,* is not a curriculum.

GRADE 7 CROSSWALK DOCUMENT

(* The 2005 content indicators that do not match 2014 content have been placed at the end of each table.)

Standard 7.P.1—Science and Engineering Practices		
2005	**2014**	**Comments**
7-1: The student will demonstrate an understanding of technological design and scientific inquiry, including process skills, mathematical thinking, controlled investigative design and analysis, and problem solving.	**7.S.1:** The student will use the science and engineering practices, including the processes and skills of scientific inquiry, to develop understandings of science content.	
Conceptual Understanding		
	7.S.1A. The practices of science and engineering support the development of science concepts, develop the habits of mind that are necessary for scientific thinking, and allow students to engage in science in ways that are similar to those used by scientists and engineers.	
Performance Indicators		
7-1.2 Generate questions that can be answered through scientific investigation.	**7.S.1A.1** Ask questions to (1) generate hypotheses for scientific investigations, (2) refine models, explanations, or designs, or (3) extend the results of investigations or challenge claims.	
	7.S.1A.2 Develop, use, and refine models to (1) understand or represent phenomena, processes, and relationships, (2) test devices or solutions, or (3) communicate ideas to others.	This is a new expectation in these standards.

7-1.1 Use appropriate tools and instruments (including a microscope) safely and accurately when conducting a controlled scientific investigation. 7-1.2 Generate questions that can be answered through scientific investigation. 7-1.3 Explain the reasons for testing one independent variable at a time in a controlled scientific investigation. 7-1.4 Explain the importance that repeated trials and a well-chosen sample size have with regard to the validity of a controlled scientific investigation. 7-1.5 Explain the relationships between independent and dependent variables in a controlled scientific investigation through the use of appropriate graphs, tables, and charts. 7-1.7 Use appropriate safety procedures when conducting investigations.	**7.S.1A.3** Plan and conduct controlled scientific investigation to answer questions, test hypotheses, and develop explanations: (1) formulate scientific questions and testable hypotheses, (2) identify materials, procedures, and variables, (3) select and use appropriate tools or instruments to collect qualitative and quantitative data, and (4) record and represent data in an appropriate form. Use appropriate safety procedures.	
7-1.5 Explain the relationships between independent and dependent variables in a controlled scientific investigation through the use of appropriate graphs, tables, and charts. 7-1.6 Critique a conclusion drawn from a scientific investigation.	**7.S.1A.4.** Analyze and interpret data from informational texts, observations, measurements, or investigations using a range of methods (such as tabulation, graphing, or statistical analysis) to (1) reveal patterns and construct meaning or (2) support hypotheses, explanations, claims, or designs.	Note that A.4 has a rich set of expectations and could be done in many instructional contexts, not just for lab investigations.

7-1.5 Explain the relationships between independent and dependent variables in a controlled scientific investigation through the use of appropriate graphs, tables, and charts.	**7.S.1A.5** Use mathematical and computational thinking to (1) use and manipulate appropriate metric units, (2) collect and analyze data, (3) express relationships between variables for models and investigations, or (4) use grade-level appropriate statistics to analyze data.	
7-1.5 Explain the relationships between independent and dependent variables in a controlled scientific investigation through the use of appropriate graphs, tables, and charts.	**7.S.1A.6** Construct explanations of phenomena using (1) primary or secondary scientific evidence and models, (2) conclusions from scientific investigations, (3) predictions based on observations and measurements, or (4) data communicated in graphs, tables, or diagrams	Students constructing their own explanations, like models in A.2. is one of the hallmarks of these new standards.
7-1.5 Explain the relationships between independent and dependent variables in a controlled scientific investigation through the use of appropriate graphs, tables, and charts. 7-1.6 Critique a conclusion drawn from a scientific investigation.	**7.S.1A.7** Construct and analyze scientific arguments to support claims, explanations, or designs using evidence from observations, data, or informational texts.	Once again, compared to E-1.4, A.7 is intended to be taught in many different contexts. One of the ideas here is that hands-on investigations and activities are great, but in the end, if students can't explain the concepts they are not instructionally appropriate.

	7.S.1A.8 Obtain and evaluate scientific information to (1) answer questions, (2) explain or describe phenomena, (3) develop models, (4) evaluate hypotheses, explanations, claims, or designs or (5) identify and/or fill gaps in knowledge. Communicate using the conventions and expectations of scientific writing or oral presentations by (1) evaluating grade-appropriate primary or secondary scientific literature, or (2) reporting the results of student experimental investigations.	
Conceptual Understanding		
	7.S.1B. Technology is any modification to the natural world created to fulfill the wants and needs of humans. The engineering design process involves a series of iterative steps used to solve a problem and often leads to the development of a new or improved technology.	
Performance Indicators		
	7.S.1B.1 Construct devices or design solutions using scientific knowledge to solve specific problems or needs: (1) ask questions to identify problems or needs, (2) ask questions about the criteria and constraints of the device or solutions, (3) generate and communicate ideas for possible devices or solutions, (4) build and test devices or solutions, (5) determine if the devices or solutions solved the problem and refine the design if needed, and (6) communicate the results	

Standard 7.P.2—Physical Science: Classification and Conservation of Matter		
2005	**2014**	**Comments**
7-5: The student will demonstrate an understanding of the classifications and properties of matter and the changes that matter undergoes. (Physical Science)	**7.P.2** The student will demonstrate an understanding of the structure and properties of matter and that matter is conserved as it undergoes changes.	
	Conceptual Understanding	
	7.P.2.A All substances are composed of one or more elements. Elements are pure substances which contain only one kind of atom. The periodic table organizes these elements based on similar properties. Compounds are substances composed of two or more elements. Chemical formulas can be used to describe compounds.	
	Performance Indicators	
	7.P.2A.1 Develop and use simple atomic models to illustrate the components of elements (including the relative position and charge of protons, neutrons, and electrons).	
7-5.4 Use the periodic table to identify the basic organization of elements and groups of elements (including metals, nonmetals, and families).	**7.P.2A.2** Obtain and use information about elements (including chemical symbol, atomic number, atomic mass, and group or family) to describe the organization of the periodic table.	
7-5.2 Classify matter as element, compound, or mixture on the basis of its composition.	**7.P.2A.3** Analyze and interpret data to describe and classify matter as pure substances (elements or compounds) or mixtures (heterogeneous or homogeneous) based on composition.	

7-5.5 Translate chemical symbols and the chemical formulas of common substances to show the component parts of the substances (including NaCl [table salt], H2O [water], C6H12O6 [simple sugar], O2 [oxygen gas], CO2 [carbon dioxide], and N2 [nitrogen gas]).	**7.P.2A.4** Construct explanations for how compounds are classified as ionic (metal bonded to nonmetal) or covalent (nonmetals bonded together) using chemical formulas.	The 2014 standard pushes the content above identifying to classifying the component parts of substances to designate them as ionic or covalent compounds.
Conceptual Understanding		
	7.P.2B. Substances (such as metals or acids) are identified according to their physical or chemical properties. Changes to substances can either be physical or chemical. Many substances react chemically with other substances to form new substances with different properties. According to the law of conservation of matter, total mass does not change in a chemical reaction.	
Performance Indicators		
7-5.9 Compare physical properties of matter (including melting or boiling point, density, and color) to the chemical property of reactivity with a certain substance (including the ability to burn or to rust).	**7.P.2B.1** Analyze and interpret data to describe substances using physical properties (including state, boiling/melting point, density, conductivity, color, hardness, and magnetic properties) and chemical properties (the ability to burn or rust).	
	7.P.2B.2 Use mathematical and computational thinking to describe the relationship between the mass, volume, and density of a given substance.	

7-5.6 Distinguish between acids and bases and use indicators (including litmus paper, pH paper, and phenolphthalein) to determine their relative pH.	**7.P.2B.3** Analyze and interpret data to compare the physical properties, chemical properties (neutralization to form a salt, reaction with metals), and pH of various solutions and classify solutions as acids or bases.	
7-5.3 Compare the physical properties of metals and nonmetals. 7-5.10 Compare physical changes (including changes in size, shape, and state) to chemical changes that are the result of chemical reactions (including changes in color or temperature and formation of a precipitate or gas).	**7.P.2B.4** Plan and conduct controlled scientific investigations to answer questions about how physical and chemical changes affect the properties of different substances.	
7-5.7 Identify the reactants and products in chemical equations. 7-5.8 Explain how a balanced chemical equation supports the law of conservation of matter.	**7.P.2B.5** Develop and use models to explain how chemical reactions are supported by the law of conservation of matter.	

7-5.1 Recognize that matter is composed of extremely small particles called atoms.

Standard 7.L.3—Life Science: Organization in Living Systems		
2005	**2014**	**Comments**
7-3: The student will demonstrate an understanding of the functions and interconnections of the major human body systems, including the breakdown in structure or function that disease causes. (Life Science)	**7.L.3:** The student will demonstrate an understanding of how the levels of organization within organisms support the essential functions of life.	
Conceptual Understanding		
	7.L.3A. Cells are the most basic unit of any living organism. All organisms are composed of one (unicellular) or many cells (multicellular) and require food and water, a way to dispose of waste, and an environment in which they can live in order to survive. Through the use of technology, scientists have discovered special structures within individual cells that have specific functions that allow the cell to grow, survive, and reproduce. Bacteria are one-celled organisms found almost everywhere and can be both helpful and harmful. They can be simply classified by their size, shape and whether or not they can move.	
Performance Indicators		
	7.L.3A.1 Obtain and communicate information to support claims that (1) organisms are made of one or more cells, (2) cells are the basic unit of structure and function of organisms, and (3) cells come only from existing cells.	

7-2.2 Compare the major components of plant and animal cells. 7-2.3 Compare the body shapes of bacteria (spiral, coccus, and bacillus) and the body structures that protists (euglena, paramecium, amoeba) use for food gathering and locomotion.	**7.L.3A.2** Analyze and interpret data from observations to describe different types of cells and classify cells as plant, animal, protist, or bacteria.	
7-2.1 Summarize the structures and functions of the major components of plant and animal cells (including the cell wall, the cell membrane, the nucleus, chloroplasts, mitochondria, and vacuoles). 7-2.2 Compare the major components of plant and animal cells. 7-2.4 Explain how cellular processes (including respiration, photosynthesis in plants, mitosis, and waste elimination) are essential to the survival of the organism.	**7.L.3A.3** Develop and use models to explain how the relevant structures within cells (including cytoplasm, cell membrane, cell wall, nucleus, mitochondria, chloroplasts, lysosomes, and vacuoles) function to support the life of plant, animal, and bacterial cells.	
	7.L.3A.4 Construct scientific arguments to support claims that bacteria are both helpful and harmful to other organisms and the environment.	
Conceptual Understanding		
	7.L.3B. Multicellular organisms (including humans) are complex systems with specialized cells that perform specific functions. Organs and organ systems are composed of cells that function to serve the needs of cells which in turn serve the needs of the organism.	

Performance Indicators		
7-3.1 Summarize the levels of structural organization within the human body (including cells, tissues, organs, and systems).	**7.L.3B.1** Develop and use models to explain how the structural organizations within multicellular organisms function to serve the needs of the organism.	
7-3.2 Recall the major organs of the human body and their function within their particular body system. 7-3.3 Summarize the relationships of the major body systems (including the circulatory, respiratory, digestive, excretory, nervous, muscular, and skeletal systems).	**7.L.3B.2** Construct explanations for how systems in the human body (including circulatory, respiratory, digestive, excretory, nervous, and musculoskeletal systems) work together to support the essential life functions of the body.	

7-3.4 Explain the effects of disease on the major organs and body systems (including infectious diseases such as colds and flu, AIDS, and athlete's foot and noninfectious diseases such as diabetes, Parkinson's, and skin cancer).

Standard 7.L.4—Life Science: Heredity—Inheritance and Variation of Traits		
2005	**2014**	**Comments**
7-2: The student will demonstrate an understanding of the structure and function of cells, cellular reproduction, and heredity. (Life Science)	**7.L.4:** The student will demonstrate an understanding of how genetic information is transferred from parent to offspring and how environmental factors and the use of technologies influence the transfer of genetic information.	
Conceptual Understanding		
	7.L.4A. Inheritance is the key process causing similarities between parental organisms and their offspring. Organisms that reproduce sexually transfer genetic information (DNA) to their offspring. This transfer of genetic information through inheritance leads to greater similarity among individuals within a population than between populations. Technology allows humans to influence the transfer of genetic information.	
Performance Indicators		
7-2.5 Summarize how genetic information is passed from parent to offspring by using the terms genes, chromosomes, inherited traits, genotype, phenotype, dominant traits, and recessive traits.	**7.L.4A.1** Obtain and communicate information about the relationship between genes and chromosomes to construct explanations of their relationship to inherited characteristics.	
7-2.5 Summarize how genetic information is passed from parent to offspring by using the terms genes, chromosomes, inherited traits, genotype, phenotype, dominant traits, and recessive traits.	**7.L.4A.2** Construct explanations for how genetic information is transferred from parent to offspring in organisms that reproduce sexually.	

7-2.6 Use Punnett squares to predict inherited monohybrid traits.	**7.L.4A.3** Develop and use models (Punnett squares) to describe and predict patterns of the inheritance of single genetic traits from parent to offspring (including dominant and recessive traits, incomplete dominance, and codominance).	
7-2.6 Use Punnett squares to predict inherited monohybrid traits.	**7.L.4A.4** Use mathematical and computational thinking to predict the probability of phenotypes and genotypes based on patterns of inheritance.	
	7.L.4A.5 Construct scientific arguments using evidence to support claims for how changes in genes (mutations) may have beneficial, harmful, or neutral effects on organisms.	
	7.L.4A.6 Construct scientific arguments using evidence to support claims concerning the advantages and disadvantages of the use of technology (such as selective breeding, genetic engineering, or biomedical research) in influencing the transfer of genetic information.	

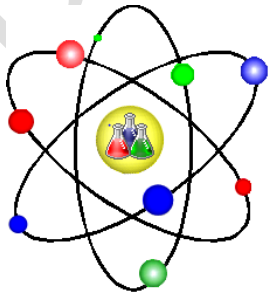
7-2.7 Distinguish between inherited traits and those acquired from environmental factors.

Standard 7.E.5—Interactions of Living Systems and the Environment		
2005	**2014**	**Comments**
7-4: The student will demonstrate an understanding of how organisms interact with and respond to the biotic and abiotic components of their environment. (Earth Science, Life Science)	**7.EC.5:** The student will demonstrate an understanding of how organisms interact with and respond to the biotic and abiotic components of their environments.	
Conceptual Understanding		
	7.EC.5A. In all ecosystems, organisms and populations of organisms depend on their environmental interactions with other living things (biotic factors) and with physical (abiotic) factors (such as light, temperature, water, or soil quality). Disruptions to any component of an ecosystem can lead to shifts in its diversity and abundance of populations.	
Performance Indicators		
7-4.1 Summarize the characteristics of the levels of organization within ecosystems (including populations, communities, habitats, niches, and biomes).	**7.EC.5A.1** Develop and use models to describe the characteristics of the levels of organization within ecosystems (including species, populations, communities, ecosystems, and biomes).	
7-4.4 Explain the effects of soil quality on the characteristics of an ecosystem.	**7.EC.5A.2** Construct explanations of how soil quality (including composition, texture, particle size, permeability, and pH) affects the characteristics of an ecosystem using evidence from soil profiles.	

7-4.3 Explain the interaction among changes in the environment due to natural hazards (including landslides, wildfires, and floods), changes in populations, and limiting factors (including climate and the availability of food and water, space, and shelter).	**7.EC.5A.3** Analyze and interpret data to predict changes in the number of organisms within a population when certain changes occur to the physical environment (such as changes due to natural hazards or limiting factors).	
Conceptual Understanding		
	7.EC.5B. Organisms in all ecosystems interact with and depend upon each other. Organisms with similar needs compete for limited resources. Food webs and energy pyramids are models that demonstrate how energy is transferred within an ecosystem	
Performance Indicators		
7-4.1 Summarize the characteristics of the levels of organization within ecosystems (including populations, communities, habitats, niches, and biomes). 7-4.3 Explain the interaction among changes in the environment due to natural hazards (including landslides, wildfires, and floods), changes in populations, and limiting factors (including climate and the availability of food and water, space, and shelter).	**7.EC.5B.1** Develop and use models to explain how organisms interact in a competitive or mutually beneficial relationship for food, shelter, or space (including competition, mutualism, commensalism, parasitism, and predator-prey relationships).	
7-4.2 Illustrate energy flow in food chains, food webs, and energy pyramids.	**7.EC.5B.2** Develop and use models (food webs and energy pyramids) to exemplify how the transfer of energy in an ecosystem supports the concept that energy is conserved.	

7-4.3 Explain the interaction among changes in the environment due to natural hazards (including landslides, wildfires, and floods), changes in populations, and limiting factors (including climate and the availability of food and water, space, and shelter).	**7.EC.5B.3** Analyze and interpret data to predict how changes in the number of organisms of one species affects the balance of an ecosystem.	
7-4.3 Explain the interaction among changes in the environment due to natural hazards (including landslides, wildfires, and floods), changes in populations, and limiting factors (including climate and the availability of food and water, space, and shelter).	**7.EC.5B.4** Define problems caused by the introduction of a new species in an environment and design devices or solutions to minimize the impact(s) to the balance of an ecosystem.	

7-4.5 Summarize how the location and movement of water on Earth's surface through groundwater zones and surface-water drainage basins, called watersheds, are important to ecosystems and to human activities.
7-4.6 Classify resources as renewable or nonrenewable and explain the implications of their depletion and the importance of conservation



CONTENT SUPPORT GUIDE FOR GRADE 7 2014 SOUTH CAROLINA ACADEMIC STANDARDS AND PERFORMANCE INDICATORS FOR SCIENCE

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SOUTH CAROLINA DEPARTMENT OF EDUCATION

The explication of the standards and performance indicators included in this document were developed under the direction of Dr. Julie Fowler, Deputy Superintendent, Division of College and Career Readiness and Cathy Jones Stork, Interim Director, Office of Standards and Learning.

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INTRODUCTION

Local districts, schools and teachers may use this document to construct standards-based science curriculum, allowing them to add or expand topics they feel are important and to organize content to fit their students' needs and match available instructional materials. The support document includes essential knowledge, extended knowledge, connections to previous and future knowledge, and assessment recommendations.

FORMAT OF THE CONTENT SUPPORT GUIDE

The format of this document is designed to be structurally uniformed for each of the academic standards and performance indicators. For each, you will find the following sections--

- **Standard**
  - This section provides the standard being explicated.
- **Conceptual Understanding**
  - This section provides the overall understanding that the student should possess as related to the standard. Additionally, the conceptual understandings are novel to the *2014 South Carolina Academic Standards and Performance Indicators for Science*.
- **Performance Indicator**
  - This section provides a specific set of content with an associated science and engineering practice for which the student must demonstrate mastery.
- **Assessment Guidance**
  - This section provides guidelines for educators and assessors to check for student mastery of content utilizing interrelated science and engineering practices.
- **Previous and Future Knowledge**
  - This section provides a list of academic content along with the associated academic standard that students will have received in prior or will experience in future grade levels. Please note that the kindergarten curriculum support document does not contain previous knowledge. Additionally, although the high school support document may not contain future knowledge, this section may list overlapping concepts from other high school science content areas.
- **Essential Knowledge**
  - This section illustrates the knowledge of the content contained in the performance indicator for which it is fundamental for students to demonstrate mastery.
- **Extended Knowledge**
  - This section provides educators with topics that will enrich students' knowledge related to topics learned with the explicated performance indicator.
- **Science and Engineering Practices**
  - This section lists the specific science and engineering practice that is paired with the content in the performance indicator. Educators should reference the chapter on this specific science and engineering practice in the *Science and Engineering Practices Support Guide.*

GRADE 7 SCIENCE CONTENT SUPPORT GUIDE

Standard 7.P.2 The student will demonstrate an understanding of the structure and properties of matter and that matter is conserved as it undergoes changes.

Conceptual Understanding
7.P.2.A All substances are composed of one or more elements. Elements are pure substances which contain only one kind of atom. The periodic table organizes these elements based on similar properties. Compounds are substances composed of two or more elements. Chemical formulas can be used to describe compounds.

Performance Indicator
7.P.2A.1 Develop and use simple atomic models to illustrate the components of elements (including the relative position and charge of protons, neutrons, and electrons).

Assessment Guidance
The objective of this indicator is to *develop and use* simple atomic models to illustrate the components of elements (including the positions of protons, neutrons and electrons. Therefore, the primary focus of assessment should be for students *to construct 2-D drawings/diagrams and 3-D models that represent or use simulations to investigate* the components of an atomic model. This could include but is not limited to students constructing/illustrating the components of atomic models to include the relative position and charge of protons, neutrons, and electrons.

In addition to *develop and use models*, students should be asked to *ask questions; plan and carry out investigations; analyze and interpret data; use mathematics and computational thinking; engage in argument from evidence; construct explanations; obtain, evaluate, and communicate information; and construct devices or define solutions.*

Previous and Future Knowledge
H.C.2 (Atomic Structure, Subatomic particles, Bohr models, Quantum mechanical models, Electron configuration, Absorption and emission spectrum, Nuclear processes: Fusion and Fission, Radioactive Decay, Half-Life and radioactive dating)

Essential Knowledge
- The atom is composed of *subatomic particles*: *protons*, *neutrons*, and *electrons* that affect the properties of an atom.
- Protons and neutrons have about the same mass.
- Protons have a positive charge, while neutrons have no charge.
- Electrons have a negative charge.
- Protons and neutrons are tightly bound in a tiny *nucleus*.
- The nucleus is located in the center of the atom with the electrons moving in random patterns in the space around the nucleus.
- An example of an atomic model for an element:

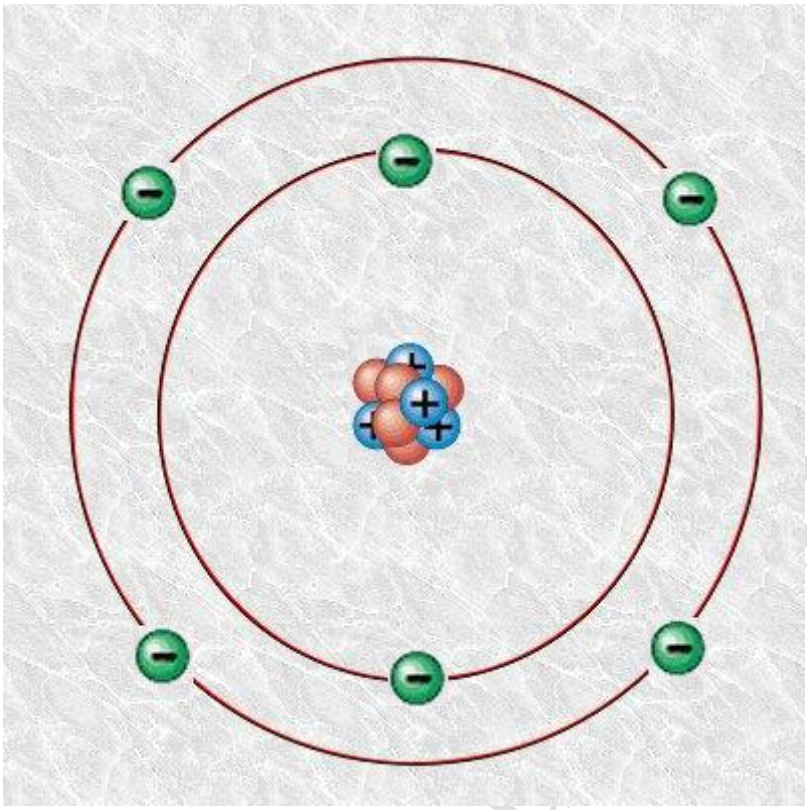


Image adapted from http://commons.wikimedia.org/wiki/File:Carbon-atom.jpg

Extended Knowledge

Students may investigate the number of electrons that can occupy each energy level and the History of the Atomic model.

- 1st- Democritus- initiated term "atoms" and stated that atoms could not be divided.
- 2nd- Dalton- theorized that atoms are too small to be seen with eye, are made up of only 1 kind of atom (Atomic Theory of Matter)
- 3rd -Thompson- used cathode ray to detect electrons and theorized that electrons were embedded in nuclei of atoms (chocolate chip model)
- 4th- Rutherford—utilized gold foil experiment involving alpha particles; theorized that atoms had a dense core which was a positive nucleus
    - Chadwick-- named neutrons
- 5th-Bohr-theorized that electrons were orbiting the nucleus

Science and Engineering Practices

S.1A.2

Standard 7.P.2 The student will demonstrate an understanding of the structure and properties of matter and that matter is conserved as it undergoes changes.

Conceptual Understanding

7.P.2.A All substances are composed of one or more elements. Elements are pure substances which contain only one kind of atom. The periodic table organizes these elements based on similar properties. Compounds are substances composed of two or more elements. Chemical formulas can be used to describe compounds.

Performance Indicator

7.P.2A.2 Obtain and use information about elements (including chemical symbol, atomic number, atomic mass, and group/family) to describe the organization of the periodic table.

Assessment Guidance

The objective of this indicator is to *obtain and use information* from secondary sources about elements to describe the organization of the periodic table. Therefore, the primary focus of assessment should be for students to *obtain and evaluate information* to research multiple elements which should be used to *(1) generate and answer questions, (2) understand trends, (3) develop (construct) models,* and *(4) support explanations* regarding the trends of the periodic table based on the elements chemical symbols, atomic numbers, atomic mass, valence electrons, group, family and determine if the element is a metal, metalloid or nonmetal. This could include but is not limited to students researching trend information from videos, informational texts, and articles and using this information to explain the organization of the periodic table and identify periodic trends for elements found in Groups 1, 2, 13-18 on the periodic table which includes the elements chemical symbol, atomic number, atomic mass. Students do NOT need to memorize the specific elements in these groups, but they should use a periodic table in order to locate and identify the requested information. In addition, students should be asked to use the atomic number and the mass number to calculate the number of protons, neutrons, and/or electrons for a given element.

In addition to *obtain and use information*, students should be asked to *ask questions; engage in argument from evidence; develop and use models; and use mathematical and computational thinking.*

Previous and Future Knowledge

- H.C.2 (Atomic Structure, Subatomic Particles, Bohr models, Quantum mechanical models, Electron configuration, Absorption and emission spectrum, Nuclear processes, Radioactive Decay, Half-Life and radioactive dating)

Essential Knowledge

- The periodic table is used to organize all of the elements.
- Every periodic table will have a square for each element with the element name, chemical/element symbol, atomic number, and atomic mass. (Students should be able to locate all on the PTE.)

Chemical/element symbols

- Each element has a different symbol.
- Symbols are written with one, two, or three letters.
- The first letter is always capitalized.
- Students should be familiar with following element names and symbols:

Element	Symbol	Element	Symbol
Hydrogen	H	Silicon	Si
Carbon	C	Copper	Cu
Nitrogen	N	Aluminum	Al
Oxygen	O	Silver	Ag
Chlorine	Cl	Gold	Au
Magnesium	Mg	Iron	Fe
Zinc	Zn	Helium	He
Calcium	Ca	Potassium	K
Phosphorus	P	Sodium	Na
Iodine	I	Fluorine	F

Atomic Number

- The *atomic number* of an element is equal to the number of protons.
- The atomic number is a whole number.
- The atomic number is always the same for a given element.
- The elements on the periodic table are arranged numerically by increasing atomic number.

Atomic Mass

- The *atomic mass* is an average sum of the number of the protons and the number of neutrons in the nucleus of the **atom**.
- Since the atomic mass of an element is an average, it is usually not a whole number.

Periods

- A horizontal row on the periodic table is called a *period*.

Families

- *Families*, also called groups, are vertical columns of elements on the periodic table
- They are numbered 1-18.
- Elements in the same family have similar properties.

Metals, Nonmetals and Metalloids

Metalloids

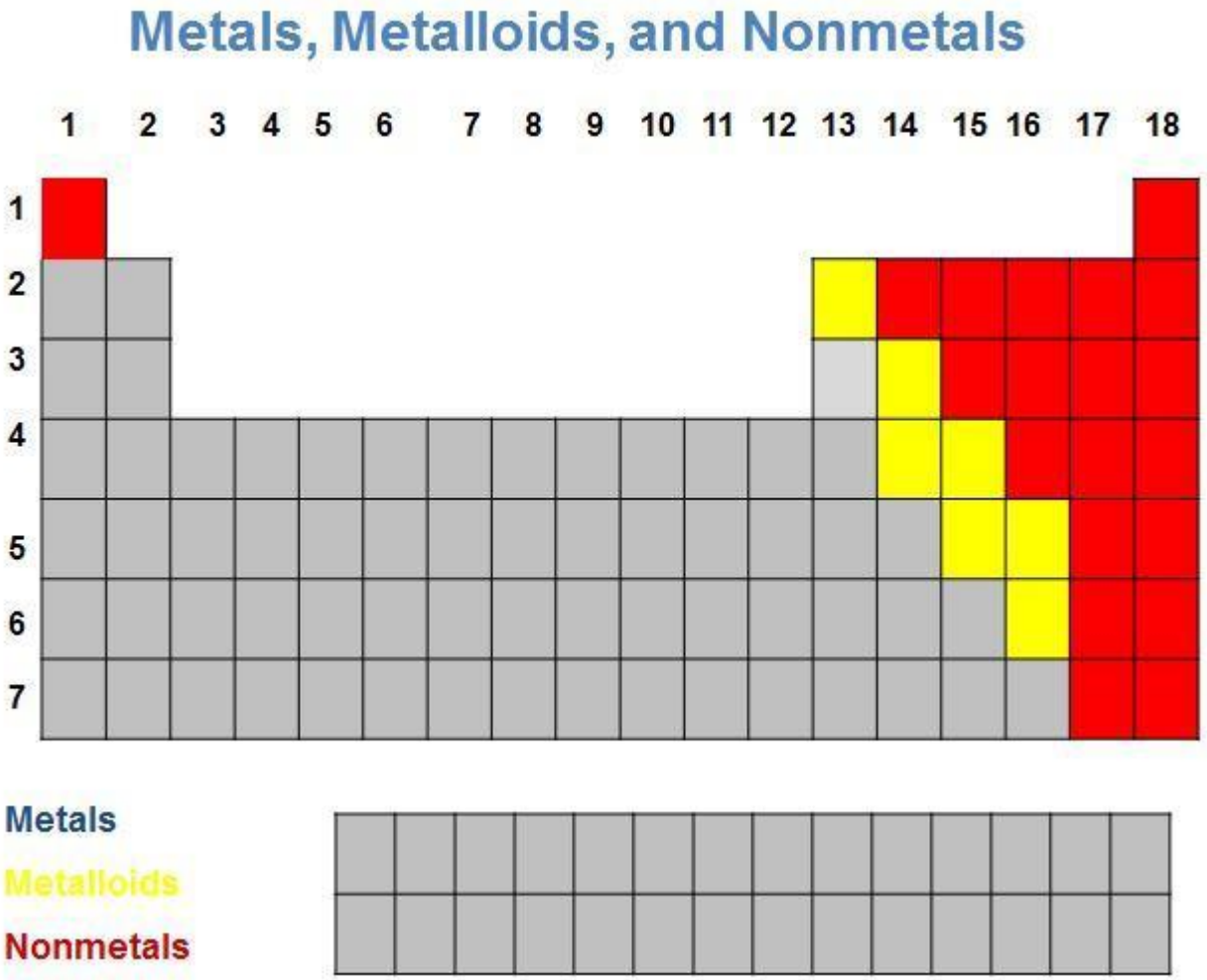
- There is a zigzag line on the right side of the periodic table that separates the metals from the nonmetals. Metalloids are found along this zigzag line.
- Elements identified as metalloids have properties (characteristics) of both metals and nonmetals.

Metals

- Metals are generally located on the left side of the zigzag line.
- Examples of metals are: Sodium (Na), Calcium (Ca), Iron (Fe), and Aluminum (Al).
- The majority of elements are metals.

Nonmetals

- Nonmetals, with the exception of Hydrogen (H), are located on the right side of the zigzag line on the periodic table.
- Examples of nonmetals are: Chlorine (Cl), Oxygen (O), Sulfur (S), and Iodine (I).



Extended Knowledge

- Students may identify patterns related to the number of valence electrons found in each family/group.
- Students may obtain and communicate information the names, characteristics, and real-world applications of the different groups.
- Students may obtain and communicate information about isotopes.

Science and Engineering Practices
S.1A.8

Standard 7.P.2 The student will demonstrate an understanding of the structure and properties of matter and that matter is conserved as it undergoes changes.

Conceptual Understanding
7.P.2.A All substances are composed of one or more elements. Elements are pure substances which contain only one kind of atom. The periodic table organizes these elements based on similar properties. Compounds are substances composed of two or more elements. Chemical formulas can be used to describe compounds.

Performance Indicator
7.P.2A.3 Analyze and interpret data to describe and classify matter as pure substances (elements or compounds) or mixtures (heterogeneous or homogeneous) based on composition.

Assessment Guidance
The objective of this indicator is to *analyze and interpret data to* describe and classify matter as pure substances or mixtures based on composition. Therefore, the primary focus of assessment should be for students *to analyze and interpret data from informational texts and data collected from investigations using a range of methods (such as tabulation, graphing, or statistical analysis) to (1) reveal patterns and construct meaning, (2) support or refute hypotheses, explanations, claims, or designs, or (3) evaluate the strength of conclusions* regarding how matter is classified as a pure substance (elements or compound) or mixture (heterogeneous or homogeneous). This could include but is not limited to students revealing patterns regarding properties of mixtures and pure substances within data from investigations in which they observe physical properties of several examples and attempt to separate the substances into separate components (through magnetism, filtration, sifting, or evaporation).

In addition to *analyze and interpret data*, students should *ask questions; plan and carry out investigations; use mathematics and computational thinking; engage in argument from evidence; construct explanations; develop and use models;* and *obtain, evaluate, and communicate information.*

Previous and Future Knowledge
- 5.P.2B.1 (Properties of Mixed Substances)
- H.C.4 (States of Matter, Phase Changes, Intermolecular Forces)

Essential Knowledge
Matter can be classified on the basis of its composition:

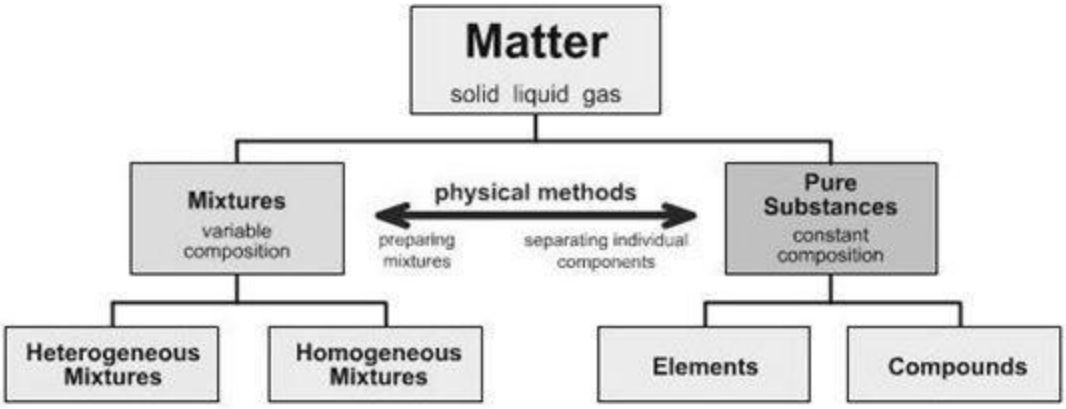


Image Source: SC 2005 Science Standard Support Document

Elements
- Elements are pure substances that cannot be changed into simpler substances.
- Elements are composed of one kind of atom.

Examples: Hydrogen, Oxygen, Carbon

Compounds

- Compounds are pure substances that are composed of two or more atoms that are chemically combined.
- Compounds can only be changed into simpler substances called elements by chemical changes.

Mixtures

- Mixtures are composed of two or more different substances that retain their own individual properties and are combined physically (mixed together).
- Mixtures can be separated by physical means (filtration, sifting, or evaporation).
- Mixtures may be heterogeneous or homogeneous.
    - In a *heterogeneous mixture*, which is not uniform throughout, the component substances can be visibly distinguished.
    - In a *homogeneous mixture*, which is uniform throughout, the substances are evenly mixed and cannot be visibly distinguished. The particles of the substances are so small that they cannot be easily seen. Another name for a homogeneous mixture is a *solution*.
- Examples: Rock, Air, Blood, Italian Salad dressing, Ocean water

Extended Knowledge

- Students can research information to design and test devices that separate heterogeneous and homogeneous mixtures.

Science and Engineering Practices

S.1A.4

Standard 7.P.2 The student will demonstrate an understanding of the structure and properties of matter and that matter is conserved as it undergoes changes.

Conceptual Understanding

7.P.2.A All substances are composed of one or more elements. Elements are pure substances which contain only one kind of atom. The periodic table organizes these elements based on similar properties. Compounds are substances composed of two or more elements. Chemical formulas can be used to describe compounds.

Performance Indicator

7.P.2A.4 Construct explanations for how compounds are classified as ionic (metal bonded to nonmetal) or covalent (nonmetals bonded together) using chemical formulas.

Assessment Guidance

The objective of this indicator is to *construct explanations* of how compounds are classified as ionic or covalent using chemical formulas***;*** therefore the focus of assessment should be for students to *construct explanations of phenomena using (1) primary or secondary scientific evidence and models, (2) conclusions from scientific investigations, (3) predictions based on observations and measurements, or (4) data communicated in graphs, tables, or diagrams to* explain how chemical formulas are constructed and classified based on ionic (metal bonded to nonmetal) and covalent bonds (nonmetals bonded together). This could include but is not limited to students making claims and using evidence from chemical formulas to identify the following as ionic or covalent compounds-- Table Salt, Water, Simple Sugar, Carbon Dioxide, Nitrogen gas, rust, and oxygen gas.

In addition to *construct explanations*, students should *ask questions; plan and carry out investigations; engage in argument from evidence; obtain, evaluate and communicate information;* and *develop and use models.*.

Previous and Future Knowledge

- H.C.3 (Properties of ionic and covalent/molecular bonding and compounds, Polyatomic ions, Periodic Table, Naming compounds and writing formulas, Oxidation numbers, Lewis Structure

Essential Knowledge

NOTE: Students should already know the symbols and names for the following common elements:

Element	Symbol	Element	Symbol
Hydrogen	H	Silicon	Si
Carbon	C	Copper	Cu
Nitrogen	N	Aluminum	Al
Oxygen	O	Silver	Ag
Chlorine	Cl	Gold	Au
Magnesium	Mg	Iron	Fe
Zinc	Zn	Helium	He
Calcium	Ca	Potassium	K
Phosphorus	P	Sodium	Na
Iodine	I	Fluorine	F

- Elements are made up of one kind of atom and the symbol for each element is unique.
- Compounds are composed of more than one atom chemically bonded, and their formulas show the different atoms that compose the compound..
- An ionic bond is formed when metals react with nonmetals, electrons are transferred from the metals to the nonmetals.
- When two or more nonmetals form compounds, they share electrons through covalent bonds. These compounds are called covalent compounds.

Chemical formulas

- Chemical formulas use element symbols from the periodic table and numerical subscripts to depict the name and number of atoms of each element in the compound; examples include: Water (H_2O), Glucose($C_6H_{12}O_6$), and Table Salt (NaCl)
- In a chemical formula, the numbers as *subscripts* show how many of each kind of atom are in the compound. The subscript is written to the lower right of the element symbol.
    - If no subscript is written, only one atom of that element is part of the compound.
    - For example, in H_2O, the number 2 is the subscript for hydrogen and means that there are 2 atoms of hydrogen in the compound of water; since there is no subscript for oxygen it is assumed to be one atom of oxygen.
- N_2, O_2, F_2, Cl_2, Br_2, I_2, and H_2 are diatomic molecules where all of the atoms of the molecule are the same element.

Ionic Bonds

- Ionic bonds are formed when metals and nonmetals chemically bond to form a new substance.
- In ionic bonds, electrons are transferred from the metals to the nonmetals.

Covalent Bonds

- Covalent bonds are formed when nonmetals bond with other nonmetals.
- In covalent bonds, electrons are shared.

NOTE: Students should be able to recognize the common names of the substances listed in the indicator (table salt, water, simple sugar, oxygen gas, carbon dioxide, and nitrogen gas) and the names and symbols for the elements listed in the chart (above). For example, students should recognize the formula H_2O as water.

Chemical Formula	Common name	Classification
NaCl	Table Salt	Ionic
H_2O	Water	Covalent
$C_6H_{12}O_6$	Simple Sugar	Covalent
O_2	Oxygen Gas	Covalent
CO_2	Carbon Dioxide	Covalent
N_2	Nitrogen Gas	Covalent
Fe_2O_3	Rust	Ionic

Extended Knowledge
Students can determine the number of electrons shared or transferred between atoms of elements to create covalent or ionic bonds.

Science and Engineering Practices
S.1A.6

Standard 7.P.2 The student will demonstrate an understanding of the structure and properties of matter and that matter is conserved as it undergoes changes.

Conceptual Understanding
7.P.2B. Substances (such as metals or acids) are identified according to their physical or chemical properties. Changes to substances can either be physical or chemical. Many substances react chemically with other substances to form new substances with different properties. According to the law of conservation of matter, total mass does not change in a chemical reaction.

Performance Indicator
7.P.2B.1 Analyze and interpret data to describe substances using physical properties (including state, boiling/melting point, density, conductivity, color, hardness, and magnetic properties) and chemical properties (the ability to burn or rust).

Assessment Guidance
The objective of this indicator is to *analyze and interpret data* to describe substances using physical properties and chemical properties. Therefore, the primary focus of assessment should be for students to *analyze and interpret data from informational texts and data collected from investigations using a range of methods (such as tabulation, graphing, or statistical analysis) to (1) reveal patterns and construct meaning, (2) support or refute hypotheses, explanations, claims, or designs, or (3) evaluate the strength of conclusions* on how to identify a substances based on physical properties (including state, boiling/melting point, density, conductivity, color,

hardness, and magnetic properties) and chemical properties (the ability to burn or rust) . This could include but is not limited to students revealing patterns and constructing meaning of data collected from hands-on investigations of physical properties and chemical properties of several common substances.

In addition to *analyze and interpret data*, students should *ask questions; plan and carry out investigations; use mathematics and computational thinking; engage in argument from evidence; construct explanations; develop and use models;* and *obtain, evaluate, and communicate information.*

Previous and Future Knowledge

- H.C.3 (Periodic Table)
- H.C.4 (States of Matter, Temperature in terms of kinetic energy, Intermolecular forces, Heating curves, Phase changes, Gas behaviors)
- H.C.5 (Solutions, Processes of Dissolving, Colligative Properties, Effects of Temperature and Pressure on Solubility, Solubility of Compounds, Percent by Volume, Molarity, Acids: Arrhenius & Bronsted-Lowery, Bases: Arrhenius & Bronsted-Lowery)
- H.C.6 (Chemical reactions: movement of ions, protons, and electrons, Oxidation and Reduction)

Essential Knowledge

- Physical and chemical properties can be used to classify and identify substances. Metals and nonmetals are two major groups of elements that have different physical properties.
- Physical properties of metals include:
    - *Luster*—Having a shiny surface or reflecting light brightly
    - *Conductors*—Heat and electricity move through them easily
    - *Malleable*—Ability to be hammered into different shapes
    - *Ductile*—Ability to be drawn into a wire
    - *High density*—Heavy for their size
- Physical properties of nonmetals include:
    - *Dull*—Not shiny
    - *Nonconductors*—Heat and electricity do not move through them easily
    - *Brittle*—Break or shatter easily (solids)

Physical properties can be observed and measured without changing the kind of matter being studied. The following physical properties can be used to help identify a substance:

Melting Point

- The temperature at which a solid can change to a liquid
- Unchanging under constant conditions
- Example: Ice melts to form liquid water at 0^oC (32^oF).

Boiling Point

- The temperature at which a liquid changes from a liquid to a gas.
- Boiling begins when bubbles form throughout, grow larger, rise to the surface, and burst.
- As long as the substance is boiling the temperature of the liquid remains constant (at the boiling point).
- Boiling point is unchanging under constant conditions for a given substance.
- Example: The boiling point for pure water at sea level is 100^oC (212^oF).

Density

- The relationship between the mass of a material and its volume
- Substances that are denser contain more matter in a given volume.

- The density of a substance is unchanging no matter how large or small the sample of the substance.
- Example:
    - Lead is a very heavy, dense metal. The density of lead is much greater than the density of the very light metal, aluminum.
    - Generally, metals have a heavier density than nonmetals.

Conductivity

- The ability to act as an electrical conductor or an electrical insulator is based on the solid's ability to complete an electric circuit, i.e., conduct electricity.
- Materials with high conductivity are called electrical conductors because they allow current to flow easily.
- Materials with low conductivity are called electrical insulators (nonconductors) because they do not allow current to flow.
- Example: Most metals are electrical conductors while nonmetals are electrical insulators.

Color

- Color can be used to help identify a substance, along with other properties.
- By itself, color is not a significant identifier of a substance.
- Absence of color is also a physical property.

Hardness

- The relative resistance of a metal or other material to denting, scratching, or bending.

Magnetism

- The property of reacting to the forces exerted by magnets
- Example:

Chemical properties

Chemical properties can be recognized only when substances react or do not react chemically with one another, that is, when they undergo a change in composition. The following chemical properties can be used to help identify a substance:

Ability to burn

The ability to burn involves a substance reacting quickly with oxygen to produce light and heat. This process is called burning

Ability to rust

The ability of a substance to rust is a chemical property that involves a substance reacting slowly with oxygen. The process is called *rusting*.

Science and Engineering Practices

S.1A.4

Standard

7.P.2 The student will demonstrate an understanding of the structure and properties of matter and that matter is conserved as it undergoes changes.

Conceptual Understanding
7.P.2B. Substances (such as metals or acids) are identified according to their physical or chemical properties. Changes to substances can either be physical or chemical. Many substances react chemically with other substances to form new substances with different properties. According to the law of conservation of matter, total mass does not change in a chemical reaction.

Performance Indicator
7.P.2B.2 Use mathematical and computational thinking to describe the relationship between the mass, volume, and density of a given substance.

Assessment Guidance
The objective of this indicator is to use *mathematical and computational* thinking to describe the relationship between the mass, volume, and density of a given substance. Therefore the focus of assessment should be for students *to construct use and manipulate appropriate metric units, (2) express relationships between variables for models and investigations, and (3) use grade-level appropriate statistics to analyze data to* use the mathematical formula for Density (D=M/V) to solve for problems related to density. This could include but is not limited to students using appropriate laboratory techniques required to measure mass and volume (of both liquids and solids of regular and irregular shapes) and calculating density from their measurements. Students could also solve for mass or volume when given density.

In addition to *use mathematical and computational thinking* students should *ask questions; plan and carry out investigations; analyze and interpret data; engage in argument from evidence; construct explanations; develop and use models; obtain, evaluate and communicate information;* and *construct devices or design solutions.*

Previous and Future Knowledge
- H.C.4 (States of Matter)

Essential Knowledge
Density
- Density is the mass of a substance per unit of volume.
- Density of a substance changes with phase changes due to the difference in the particle arrangement in solids, liquids and gasses. The volume and density of a particular substance is dependent upon its phase or state of matter.
- Density is calculated using the formula: density = mass/volume
- Volume is measured in milliliters (mL) and can be calculated using basic mathematical computations or the liquid displacement method.
- Mass is measured in grams.
- The composition of a substance does not change when one measures mass and volume. Density, therefore, is a physical property.
- Example: If the mass of an object is 20 grams and the volume of the same object is 10 mL, what is the density of the object?

D=20g/10mL
D= 2 g/mL

Misconception: Students can often manipulate and solve the density equation without a grasp of the proportional thinking required to truly understand the concept. Understanding a ratio requires that students think abstractly, a cognitive skill that many physical science students have not yet acquired. It is therefore essential that this concept be introduced in a concrete manner.

Extended Knowledge
Students could explore specific gravity.

Science and Engineering Practices
S.1A.5

Standard 7.P.2 The student will demonstrate an understanding of the structure and properties of matter and that matter is conserved as it undergoes changes.

Conceptual Understanding
7.P.2B. Substances (such as metals or acids) are identified according to their physical or chemical properties. Changes to substances can either be physical or chemical. Many substances react chemically with other substances to form new substances with different properties. According to the law of conservation of matter, total mass does not change in a chemical reaction.

Performance Indicator
7.P.2B.3 Analyze and interpret data to compare the physical properties, chemical properties (neutralization to form a salt, reaction with metals), and pH of various solutions and classify solutions as acids or bases.

Assessment Guidance
The objective of this indicator is to *analyze and interpret* data to compare the physical properties, chemical properties (neutralization to form a salt, reaction with metals), and pH of various solutions and classify solutions as acids or bases. Therefore, the primary focus of assessment should be for student *to analyze and interpret data from informational texts and data collected from investigation to (1) classify a given solution, and (2) justify the classification based on information*. This could include but is not limited to students using different indicators to obtain data regarding the pH of several solutions. They could then classify the solutions as an acid or base based on their observations and background information obtained from informational texts regarding the behavior and ranges of the indicators.

In addition to *analyze and interpret data*, students should be asked to *ask questions; plan and carry out investigations; use mathematics and computational thinking; engage in argument from evidence; construct explanations; develop and use models;* and *obtain, evaluate, and communicate information.*

Previous and Future Knowledge
- 5.P.2B.4 (Concentrations of Solutions, Solute and Solvent)
- H.C.6 (Chemical Reactions, Oxidation and Reduction)
- H.C.5 (Acids: Arrhenius & Bronsted-Lowery, Bases: Arrhenius & Bronsted-Lowery, Salts, pH, pOH, Neutralization)
- H.C.3 (Ionic & Molecular/Covalent Bonding, Properties of Ionic and Covalent Compounds)

Essential Knowledge
- Physical properties can be observed without changing the composition of the substance.
- Chemical properties can only be observed by changing the composition of the substance, forming new substances.

	Chemical Properties	Physical Properties	pH	Examples
Acids (Acidic solutions)	• React with some metals to give off a gas • Neutralization occurs when acids and bases react with each other. They can form a salt and usually water. • React with blue litmus paper turning it red • Does not react with red litmus paper and the litmus paper will remain red. • Doesn't react with phenolphthalein	• Tastes sour Sticky texture	0-6.9	- Hydrochloric acid - Vinegar (Acetic acid) - Orange juice
Bases (Basic solutions)	• Neutralization occurs when bases and acids react with each other. They can form a salt and usually water. • React with red litmus paper turning it blue. • Does not react with blue litmus paper and the litmus paper will remain red. • Reacts with phenolphthalein turning it magenta.	• Tastes bitter Slippery texture	7.1-14	- Baking soda (Sodium bicarbonate) - Sodium hydroxide (drain cleaner) - Antacid
Neutrals (Neutral solutions)	• Are formed when neutralization occurs between acids and bases. • Neither an acid nor a base. • React with litmus paper turning it violet. • Doesn't react with phenolphthalein.		7	Distilled water

Indicators

Litmus paper

- Has a special dye on it that changes colors in the presence of an acid or base.
- Blue litmus paper turns red in an acid, and stays blue in a base.
- Red litmus paper turns blue in a base, and stays red in an acid.

Phenolphthalein

- Is used to test for the presence of a base.
- It is a colorless chemical that turns magenta (bright pink) in a base, and stays colorless in neutral or acidic solutions.

pH paper

- Has a range of colors depending on the pH of the solution.
- The color of the paper is compared to the chart on the vial to determine the pH.

NOTE**:** Students should not use a taste test on laboratory chemicals. Touching an unknown substance to observe if it feels slippery should not be done on laboratory chemicals as some strong bases burn the skin when touched.

Extended Knowledge

- Many household cleaners are classified as bases. Students can explore the many uses of acids and bases.
- The formula of a base can be recognized because the formula typically ends in OH.
- The formula of an acid can be recognized because the first element in the formula is typically hydrogen.
- Students may perform a neutralization of a solution to form water and salt or investigate how to use other indicators to determine the pH of a solution (such as purple/red cabbage juice and pH meters). Students may also calculate and identify substances as acids or bases using pOH.

Science and Engineering Practices
S.1A.4

Standard 7.P.2 The student will demonstrate an understanding of the structure and properties of matter and that matter is conserved as it undergoes changes.

Conceptual Understanding
7.P.2B. Substances (such as metals or acids) are identified according to their physical or chemical properties. Changes to substances can either be physical or chemical. Many substances react chemically with other substances to form new substances with different properties. According to the law of conservation of matter, total mass does not change in a chemical reaction.

Performance Indicator
7.P.2B.4 Plan and conduct controlled scientific investigations to answer questions about how physical and chemical changes affect the properties of different substances.

Assessment Guidance
The objective of this indicator is to *plan and conduct controlled scientific investigations* to answer questions about how physical and chemical changes affect the properties of different substance**s** therefore the focus of this assessment should be for students to *plan and conduct controlled scientific investigations to answer questions, test hypotheses, and develop explanations: (1) formulate scientific questions and testable hypotheses based on credible scientific information, (2) identify materials, procedures, and variables, (3) use appropriate laboratory equipment, technology, and techniques to collect qualitative and quantitative data, and (4) record and represent data in an appropriate form*. This could include but is not limited to students designing, conducting, and presenting data from investigation on physical changes (phase changes between states of matter) as well as chemical changes resulting in the creation of a new substance (including changes in color, temperature change, and formation of a precipitate and/or gas).

In addition to *plan and conduct investigations*, students may be expected to *ask questions; analyze and interpret data; use mathematics and computational thinking; engage in argument from evidence; construct explanations;* and *develop and use models*.

Previous and Future Knowledge

- 5.P.2A.1 Properties of solids, liquids, and gases
- H.C.3: Bonding: Ionic and molecular (covalent), Properties of ionic and covalent compounds, Hydrocarbons, Isomers
- H.C.6: Chemical reactions: movement of ions, protons, and electrons, Oxidation and Reduction

Essential Knowledge

Physical and chemical changes affect substances in different ways.

Physical changes do not change the composition of a substance, only the physical properties. Evidences of a physical change include:

- Change in state of matter
    - When a substance changes from one state of matter to another (for example, changing from solid to liquid, from liquid to solid, or from liquid to gas), the composition of the substance remains the same.
    - Examples of change in state might include: melting of ice cream, hardening of melted wax, or evaporating of water from wet clothes.

- Change in size or shape
    - When a substance changes in size or shape (for example, cutting, tearing, dissolving, stretching, or wrinkling), its composition remains the same.
    - Examples of change in size or shape might include: shredding paper, dissolving sugar in water, stretching a rubber band, wadding up a piece of paper, or denting a piece of metal.

Chemical changes result in the formation of one or more new substances with new chemical and physical properties. Evidences that a chemical change may have occurred include:

- Color change
    - When a substance changes color, the chemical composition of the substance may have changed (for example, iron turns to a reddish-brown when it rusts, clothes change color when bleach is added, apples turn brown when they react with oxygen in the air, or marshmallows turn black when burned).
    - It is possible to have a color change without a chemical change (for example, adding food coloring to water).
- Temperature change
    - When a substance is combined with another substance, there may be an increase or decrease in temperature (for example, when wood burns to ash and gases, the temperature increases).
    - It is possible to have a temperature change without a chemical change usually due to a heat source (for example, warming of the water in a pot).
- Formation of a precipitate
    - When two solutions are combined, they may form a new solid substance. This solid substance is called a *precipitate* and indicates that a chemical change has occurred.
    - For example when carbon dioxide is combined with aqueous calcium hydroxide (limewater), solid calcium carbonate (chalk) is formed as the precipitate.
    - The precipitate may be in the form of very small particles, appearing as cloudiness in the solution or as a solid which settles to the bottom of the container.
- Formation of a gas
    - When solid or liquid substances are combined, they may form gas bubbles or smoke indicating that a chemical reaction has taken place.

- For example when vinegar is added to baking soda, it forms carbon dioxide bubbles.
- It is possible to form gas without a chemical change (for example, when water is heated to boiling).

Extended Knowledge
Students may identify a reaction as exothermic or endothermic. Students may investigate sublimation (when a substance changes directly from a gas to a solid, for example, the forming of frost from water vapor) and construct an explanation of why it is a physical change.

Science and Engineering Practices
S.1A.3

Standard 7.P.2 The student will demonstrate an understanding of the structure and properties of matter and that matter is conserved as it undergoes changes.

Conceptual Understanding
7.P.2B. Substances (such as metals or acids) are identified according to their physical or chemical properties. Changes to substances can either be physical or chemical. Many substances react chemically with other substances to form new substances with different properties. According to the law of conservation of matter, total mass does not change in a chemical reaction.

Performance Indicator
7.P.2B.5 Develop and use models to explain how chemical reactions are supported by the law of conservation of matter.

Assessment Guidance
The objective of this indicator is to *develop and use models* to explain how chemical reactions are supported by the law of conservation of matter. Therefore, the primary focus of assessment should be for students to *construct 2-D drawings/diagrams and 3-D models that represent or use simulations to investigate* when a substance is broken apart or combined at least one new substance is formed and no new matter was created or that matter was not lost. This could include but is not limited to students using chemical equations to illustrate a chemical reaction by identifying and labeling the product(s) and reactant(s) and identifying the Law of Conservation of Matter by observing a balanced (equal) number of atoms on both sides of the equation.

In addition to *develop and use models*, students should be asked to *ask questions; plan and carry out investigations; analyze and interpret data; use mathematics and computational thinking; engage in argument from evidence; construct explanations;* and *obtain, evaluate, and communicate information.*

Previous and Future Knowledge
- H.C.6 (Chemical Reactions, Oxidation and Reduction, Conservation of Mass, Stoichiometry, Limiting reactants, Percent Yield)
- H.C.7 (Law of Conservation of Energy)

Essential Knowledge
When a substance is broken apart or when substances are combined and at least one new substance is formed, a *chemical reaction* has occurred. Chemical equations are used to represent a chemical reaction. It contains the chemical names or the chemical formulas of the substances that are involved in the reaction. An arrow is used

to distinguish between the reactants and the products in the reaction. This arrow can be translated as "yields" or "makes."

Reactants are substances broken apart or combined in a chemical reaction and are located on the left side of the arrow. *Products* are new substances formed in a chemical reaction and are located on the right side of the arrow.

For example, the following chemical equation shows the formation of water (H_2O) from oxygen gas (O_2) and hydrogen gas (H_2). The reactants are oxygen gas (O_2) and hydrogen gas ($2H_2$), located on the left side of the arrow. The product, water ($2H_2O$), is on the right side of the arrow.

Reactant		**Product**
Hydrogen gas + Oxygen gas	Yields/Makes	Water
$2H_2 + O_2$	→	$2H_2O$

Law of Conservation of Matter states that the amount of matter does not change during a chemical reaction, only that the atoms are rearranged to form new substances. Another interpretation of this law is that matter can neither be created nor destroyed, but can be changed in form. Because matter is neither created nor destroyed, the total mass of the material(s) before the reaction is the same as the total mass of material(s) after the reaction.

A *balanced chemical equation* has the same number of each kind of atom on the reactant side as on the product side. To determine whether a chemical equation is balanced, two numbers are considered: the *subscript* and the *coefficient*. A *coefficient* is the number that comes before the chemical formula and indicates the number of particles that participate in the reaction. The *subscript* is the number written below the symbol for the element and tells the number of atoms in the element.

In order to determine whether an equation is balanced, one must

- multiply the number in front of the chemical formula in the equation (coefficient) by the number written below the symbol for the element(s) (subscript) in the formula. If no coefficient is written, it is understood to be one. For instance, for "$2H_2O$" there are 4 hydrogen atoms and 2 oxygen atoms. If no subscript is written, it is understood to be 1.
- Determine if the number of each kind of atom on the left side of the arrow is equal to the number of each kind of atom on the right side of the arrow.

For example, in the chemical equation for the reaction of water (liquid) breaking into hydrogen (gas) and oxygen (gas) as represented by the balanced chemical equation:

$$2H_2O \rightarrow 2H_2 + O_2$$

- There are four hydrogen atoms on the reactant side (coefficient of 2 x subscript 2) and four hydrogen atoms on the product side (coefficient 2 x subscript 2).
- There are two oxygen atoms on the reactant side (coefficient 2 x (understood) subscript 1) and two oxygen atoms on the product side ((understood coefficient 1 x subscript 2).
- There are the same number of hydrogen atoms (4) and oxygen atoms (2) on both sides of the equation; therefore, the equation is balanced.
- Since there are the same number of each kind of atom on both sides of the arrow and atoms represent kinds of matter, the amount of matter is the same on both sides of the equation, which supports the law of conservation of matter.

Extended Knowledge
Students may use mathematical and computational thinking to balance various types of chemical reactions that occur (single displacement, double displacement, decomposition, or synthesis) or determine the products in a chemical reaction given the reactants. Students may also use mathematical and computational thinking to balance chemical equations with polyatomic ions (for example, $(NH_4)_2CO_3$ ammonium carbonate).

Science and Engineering Practices
S.1A.2

Standard 7.L.3 The student will demonstrate an understanding of how the levels of organization within organisms support the essential functions of life.

Conceptual Understanding
7.L.3A Cells are the most basic unit of any living organism. All organisms are composed of one (unicellular) or many cells (multicellular) and require food and water, a way to dispose of waste, and an environment in which they can live in order to survive. Through the use of technology, scientists have discovered special structures within individual cells that have specific functions that allow the cell to grow, survive, and reproduce. Bacteria are one-celled organisms found almost everywhere and can be both helpful and harmful. They can be simply classified by their size, shape and whether or not they can move.

Performance Indicator
7.L.3A.1 Obtain and communicate information to support claims that (1) organisms are made of one or more cells, (2) cells are the basic unit of structure and function of organisms, and (3) cells come only from existing cells

Assessment Guidance
The objective of this indicator is to *obtain and communicate information* to support claims that (1) organisms are made of one or more cells, (2) cells are the basic unit of structure and function of organisms, and (3) cells come only from existing cells. Therefore, the primary focus of assessment should be for students to *obtain and communicate scientific information (from investigations and primary and secondary sources) to describe the evidence used to support the claims* of the cell theory. This could include but is not limited to students describing the experiments that led to the scientists "disproving" the theory of spontaneous generation and how these results supported the tenets of cell theory (organisms are made of one or more cells, cells are the basic unit of structure and function of organisms, and cells come only from existing cells).

In addition to *obtaining and communicating information*, students should *ask questions; plan and carry out investigations; analyze and interpret data; use mathematics and computational thinking; engage in argument from evidence; construct explanations; develop and use models*; and *construct devices or define solutions*.

Previous and Future Knowledge
H.B. 2 (Cell Systems)

Essential Knowledge
The Cell Theory was developed as a result of analyzing data gathered from experimentation.
It is essential for students to identify the three tenets of the Cell Theory.

- All living things are made of one or more cells
- The cell is the basic unit of life.

- All cells come from preexisting cells.

Extended Knowledge

- Students could obtain and communicate information to further develop their understanding of cells and the Cell Theory.
- The student can develop and use models to describe cells, the differences between unicellular and multicellular life, and mitosis.
- A unicellular organism is composed of one cell and all of life's activities occur within that single cell.
- In a multicellular organism, each cell carries on most of the major functions of life.
- The ability of cells to divide to form new cells is the basis for all reproduction (both sexual and asexual) and for the growth and repair of all multicellular organisms. This process is called mitosis.

Science and Engineering Practices
S.1A.8

Standard 7.L.3 The student will demonstrate an understanding of how the levels of organization within organisms support the essential functions of life.

Conceptual Understanding
7.L.3A Cells are the most basic unit of any living organism. All organisms are composed of one (unicellular) or many cells (multicellular) and require food and water, a way to dispose of waste, and an environment in which they can live in order to survive. Through the use of technology, scientists have discovered special structures within individual cells that have specific functions that allow the cell to grow, survive, and reproduce. Bacteria are one-celled organisms found almost everywhere and can be both helpful and harmful. They can be simply classified by their size, shape and whether or not they can move.

Performance Indicator
7.L.3A.2 Analyze and interpret data from observations to describe different types of cells and classify cells as plant, animal, protist, or bacteria.

Assessment Guidance
The objective of this indicator is to *analyze and interpret data* to describe different types of cells and classify cells. Therefore the primary focus of assessment should be for students to *analyze and interpret data from informational texts, observations, measurements, or investigations* to provide evidence that cells can be classified as plant, animal, bacteria, or protist based on the characteristics of the cells. This could include but is not limited to students examining cells and determining the cell type based on key characteristics that they observe. In addition, students should identify trends, patterns, and relationships within the data and images that they observe.

In addition to *analyzing and interpreting data*, students should *ask questions; plan and carry out investigations; use mathematics and computational thinking; engage in argument from evidence; construct explanations; develop and use models*; *obtain, evaluate, and communicate information;* and *construct devices or define solutions*.

Previous and Future Knowledge
- 6.L.4 (Classification of Organisms Structures, Processes, Behaviors, and Adaptations of Animals)
- H.B. 2 (Cell Systems)

Essential Knowledge
It is essential that students be able to analyze and interpret data to describe and classify a cell as plant, animal, bacteria, or protist.
Structures that are common to plant and animal cells are the cell membrane, nucleus, mitochondria, and vacuoles.
Structures that are specific to plants are the cell wall and chloroplasts.
Major structural differences between a plant and an animal cell include:
- Plant cells have a cell wall, but animal cells do not. Cell walls provide support and give shape to plants.
- Plant cells have chloroplasts, but animal cells do not. Chloroplasts enable plants to perform photosynthesis to make food.
- Plant cells usually have one or more large vacuole(s), while animal cells have smaller vacuoles, if any are present. Large vacuoles help provide shape and allow the plant to store water and food for future use. The storage function plays a lesser role in animal cells, therefore the vacuoles are smaller.

The student should be able to describe and classify an organism as prokaryotic or eukaryotic.
- Prokaryotic organisms are cells that lack a nucleus and membrane-bound organelles. Bacteria compose the majority of prokaryotic organisms.
- Eukaryotic organisms are cells that contain a membrane bound nucleus and organelles. Plant, animal, and protist are eukaryotic.

The student should be able to describe and classify an organism as unicellular or multicellular.
- Unicellular organisms are composed of one cell and would include most protists and bacteria.

The student should be able to describe and classify an organism as photosynthetic or non-photosynthetic.
- Cells that are photosynthetic contain chloroplasts and the pigment chlorophyll. This would include most cells of the plant kingdom and some protist
- Non-photosynthesizing cells would lack chloroplasts and chlorophyll. This would include cells of the animal kingdom.

Extended Knowledge
When discussing cell types, it is important to explain that form follows function. To extend the student's knowledge, teachers may want students to explore how the function of a cell can affect the cell's structure. Some cells will deviate from the cell description depending on their individual needs. For example, red blood cells do not contain a nucleus (but are still eukaryotic) in order to increase oxygen binding capability. The student should be able to construct explanations as to why it is beneficial for some cells to be structurally different from "typical" cells. There are many specialized processes that occur within the cell. Students may create and use models to explore photosynthesis on a deeper level, including light and light-independent (Calvin cycle) reactions, and CAM plants.

Science and Engineering Practices
S.1A.4

Standard 7.L.3 The student will demonstrate an understanding of how the levels of organization within organisms support the essential functions of life.

Conceptual Understanding
7.L.3A Cells are the most basic unit of any living organism. All organisms are composed of one (unicellular) or many cells (multicellular) and require food and water, a way to dispose of waste, and an environment in which they can live in order to survive. Through the use of technology, scientists have discovered special structures within individual cells that have specific functions that allow the cell to grow, survive, and reproduce. Bacteria are one-celled organisms found almost everywhere and can be both helpful and harmful. They can be simply classified by their size, shape and whether or not they can move.

Performance Indicator
7.L.3A.3 Develop and use models to explain how the relevant structures within cells (including cytoplasm, cell membrane, cell wall, nucleus, mitochondria, chloroplasts, lysosomes, and vacuoles) function to support the life of plant, animal, and bacterial cells.

Assessment Guidance
The objective of this indicator is to *develop and use models* to explain how various organelles within a cell function and relate their function to the cell's overall survival. Therefore, the primary focus of assessment should be for students to *construct drawings/diagrams and models* to explain how the relevant structures within cells (including cytoplasm, cell membrane, cell wall, nucleus, mitochondria, chloroplasts, lysosomes, and vacuoles) function to support the life of plant, animal, and bacterial cells. This could include but is not limited to students developing models from sources of evidence and scientific information. This means they should be able to use information (obtained through research or investigations) to develop and construct a functional, descriptive model that represents relevant cell processes. This is not simply copying a pre-existing model from some source.

In addition to *develop and use models*, students should be asked to *ask questions; plan and carry out investigations; analyze and interpret data; use mathematics and computational thinking; engage in argument from evidence; construct explanations; obtain, evaluate, and communicate information;* and *construct devices or define solutions*

Previous and Future Knowledge
H.B. 2 (Cell Systems)

Essential Knowledge
It is essential for students to be able to develop and use models to explain how various organelles within a cell function and relate their function to the cell's overall survival. Some cellular structures and their functions include:
Cell membrane
- The thin, flexible outer covering of a cell. It controls what enters and leaves a cell.
- There are two main ways substances enter and leave a cell::
  - Diffusion is one way in which materials (for example molecules of sugar, water or waste) moves across the cell membrane. It occurs as materials move from an area of higher concentration to an area of lower concentration.
  - Osmosis is the diffusion of water across a membrane.

Cytoplasm
- The gel-like fluid inside of a cell made of mostly water.
- The other organelles are embedded in the cytoplasm.

Nucleus
- Contains the genetic material (DNA) and is the control center of the cell.

- One type of cellular reproduction, mitosis, occurs in the nucleus. This results in a duplicate copy of the cell. Mitosis is needed for growth, replacement of cells, and asexual reproduction.

Vacuole

- Act as temporary storage centers.
- Some store water; others store waste products until they can be eliminated from the cell.
- Plant cells have fewer and larger vacuoles than animal cells.

Chloroplasts

- Are the sites where photosynthesis takes place in a plant cell
- They contain the chlorophyll, the green pigment that absorbs light energy
- During the process of photosynthesis, plants use light energy (sunlight), carbon dioxide (CO_2), and water (H_2O) to make glucose, a simple sugar ($C_6H_{12}O_6$) and oxygen gas (O_2)
- Plant cells also release oxygen gas (O_2) as a waste product of photosynthesis

Mitochondria

- It is sometimes called the "powerhouse" of the cell
- Are the energy producing sites in the cell where respiration takes place
- All organisms undergo cellular respiration. During this process, glucose ($C_6H_{12}O_6$) is broken down into carbon dioxide (CO_2) and water (H_2O) to release energy
- The cell uses the energy to build, repair, and reproduce cells
- Cellular respiration is the complementary process to photosynthesis
- Cells that require a larger amount of energy to function contain a larger number of mitochondria

Cell wall

- Provides support and shape for plant cells. It is made mostly of cellulose which provides a protective framework for the cell

Lysosomes

- Organelles responsible for digesting certain materials within the cell
- The lysosome can digest food, worn out organelles, as well as other cellular waste not needed for cell metabolism

Extended Knowledge

From this information, students should develop and use models to describe the process of mitosis. The student can also use mathematical and computational thinking to describe what happens with the number of chromosomes during the process of cell division.

Science and Engineering Practices

S.1A.2

Standard 7.L.3 The student will demonstrate an understanding of how the levels of organization within organisms support the essential functions of life.

Conceptual Understanding

7.L.3A Cells are the most basic unit of any living organism. All organisms are composed of one (unicellular) or many cells (multicellular) and require food and water, a way to dispose of waste, and an environment in which they can live in order to survive. Through the use of technology, scientists have discovered special structures within individual cells that have specific functions that allow the cell to grow, survive, and reproduce. Bacteria are one-celled organisms found almost everywhere and can be both helpful and harmful. They can be simply classified by their size, shape and whether or not they can move.

Performance Indicator
7.L.3A.4 Construct scientific arguments to support claims that bacteria are both helpful and harmful to other organisms and their environment.

Assessment Guidance
The objective of this indicator is to *construct scientific arguments* to support claims that bacteria are both helpful and harmful to other organisms and their environment. Therefore, the primary focus of assessment should be for students to construct and analyze scientific arguments to *support claims, explanations, or designs using evidence from observations, data, or informational texts* that bacteria can be both helpful and harmful. This could include but is not limited to students being able to describe both helpful and harmful bacteria. Students engage in reasoning and argumentation from evidence to propose new explanations and theories, to interpret data, and to propose and evaluate technological design solutions. Students are to *construct scientific arguments* supported by data; use evidence to support claims made about natural phenomena, (evidence can come from student generated observations, measurements, models, scientific text and media, and secondary sources of data), analyze and evaluate other claims based on scientific evidence, determine if the evidence supports a scientific claim, and use evidence to support claims made about designs and solutions.

In addition to being able to *construct scientific arguments,* students should be asked to *ask questions, plan and carry out investigations, analyze and interpret data, use mathematics and computational thinking, construct explanations, obtain, evaluate and communicate information, develop and use models,* and *construct devices or design solutions*.

Previous and Future Knowledge
H.B.6 (Ecosystems)

Essential Knowledge
It is essential that students be able to describe both helpful and harmful bacteria. Bacteria can be helpful to organisms and the environment

- Bacteria are in our digestive system and aid in breaking down and absorbing food.
- Bacteria are used to make a variety of foods including cheese and yogurt.
- Bacteria can decompose dead organisms and release those nutrients back into the environment.

Bacteria can be harmful to organisms and the environment

- Bacteria can be pathogens and cause diseases like strep throat, food poisoning, and tuberculosis.
- Bacteria, such as wheat blight can infect plants that are used as crops.

Extended Knowledge
To extend the student's knowledge, students may construct scientific arguments to support claims that specific bacteria can be both helpful and harmful:
Some bacteria can be classified as both helpful and harmful depending on the location of infection in the human body. For example, E. coli bacteria naturally live in the human intestine. E. coli is essential for digestion to occur. However, if E. coli enters the stomach through contaminated food, it can cause foodborne illness.

Teachers should not limit the discussion of harmful bacteria to just strep throat. Other bacterial pathogens that could be considered are tetanus, bacterial pneumonia, and a variety of other infectious diseases that can affect a variety of living organisms.

Science and Engineering Practices
S.1A.7

Standard 7.L.3 The student will demonstrate an understanding of how the levels of organization within organisms support the essential functions of life.

Conceptual Understanding

7.L.3B Multicellular organisms (including humans) are complex systems with specialized cells that perform specific functions. Organs and organ systems are composed of cells that function to serve the needs of cells which in turn serve the needs of the organism.

Performance Indicator

7.L.3B.1 Develop and use models to explain how the structural organizations within multicellular organisms function to serve the needs of the organism.

Assessment Guidance

The objective of this indicator is to *develop and use models* to explain how the structural organizations within multicellular organisms function to serve the needs of the organism. Therefore, the primary focus of assessment should be for students to *construct drawings/diagrams and models* to explain how the relevant structures within multicellular organisms function to support life. This could include but is not limited to students developing models that show how the cells, tissues, organs, and organ systems work together to enable living things to conduct all necessary functions of life. . This is not simply copying a pre-existing model from some source. Students should use models to explain how the function of one level of the hierarchical structure enables the functions of the other levels.

In addition to *develop and use models*, students should be asked to *ask questions; plan and carry out investigations; analyze and interpret data; use mathematics and computational thinking; engage in argument from evidence; construct explanations; obtain, evaluate, and communicate information;* and *construct devices or define solutions*

Previous and Future Knowledge

H.B. 2 (Cell Systems)

Essential Knowledge

It is essential for the student to be able to relate organization within an organism. The levels of organization, from the simplest level to the most complex are:

- Cells - The basic units of structure and function within all living things. Though all cells perform the processes that keep the organism alive, they also have specialized functions as well. Examples may be nerve cells (neurons), blood cells, and bone cells, in animals and guard cells, xylem cells and phloem cells in plants.
- Tissues - A group of specialized cells that work together to perform a specific function. Examples of the main types of tissue in animals are nervous tissue, connective tissue, muscle tissue, and epithelial tissue. Plants contain xylem and phloem tissue that is comprised of xylem and phloem cells.
- Organs - A group of two or more different types of tissue that work together to perform a specific function. The task is generally more complex than that of the tissue. For example, the heart is made of muscle and connective tissues which function to pump blood throughout an animal. Flowers, roots, and stems are organs in plants..
- Systems - A group of two or more organs that work together to perform a specific function. Each organ system has its own function but the systems work together and depend on one another. Plants and animals have a reproductive system.

Extended Knowledge
The students can develop and use models to show the differences between the levels of organization.
NOTE TO TEACHER: The reproductive system is not a part of the science curriculum.
Science and Engineering Practices
S.1A.2

Standard 7.L.3 The student will demonstrate an understanding of how the levels of organization within organisms support the essential functions of life.

Conceptual Understanding
7.L.3B Multicellular organisms (including humans) are complex systems with specialized cells that perform specific functions. Organs and organ systems are composed of cells that function to serve the needs of cells which in turn serve the needs of the organism.

Performance Indicator
7.L.3B.2 Construct explanations for how systems in the human body (including circulatory, respiratory, digestive, excretory, nervous, and musculoskeletal systems) work together to support the essential life functions of the body.

Assessment Guidance
The objective of this indicator is to *construct explanations* for how systems in the human body (including circulatory, respiratory, digestive, excretory, nervous, and musculoskeletal systems) work together to support the essential life functions of the body. Therefore, the primary focus of assessment should be for students to *construct explanations of phenomena using (1) primary or secondary scientific evidence and models, (2) conclusions from scientific investigations, (3) predictions based on observations and measurements, or (4) data communicated in graphs, tables, or diagrams* that demonstrate the basic form and function of each of the body systems as well as the interrelationships between systems. This could include but is not limited to students being able to understand the basic form and function of each of the body systems listed in this indicator as well as the interrelationships between systems that ensure the survival of the organism.

In addition to *construct explanations*, students should ask questions, plan and carry out investigations, analyze and interpret data, use mathematical and computational thinking, engage in argument from evidence, obtain, evaluate and communicate information, develop and use models, and construct devices or design solutions.

Previous and Future Knowledge
H.B.4 (Cell Systems)

Essential Knowledge
It is essential for the student to be able to understand the basic form and function of each of the following body systems as well as the interrelationships that occur between systems to ensure the survival of the organism.
Circulatory System

- The main function of the circulatory system is to transport blood to all parts of the body so that gases, nutrients, and waste products are transported to and from the cells.
- The white blood cells within the circulatory system help to fight infection in the body.
- The main organs of the circulatory system are:
    1) Heart - Causes blood to circulate through the body by its pumping action

2) Blood Vessels (arteries, veins, & capillaries) - tubes that carry blood throughout the entire body.

- Most arteries carry blood that has oxygen and nutrients to all the parts of the body.
- Most veins carry waste products (for example carbon dioxide) from all the parts of the body back to the heart.
- Capillaries are very small vessels where the exchange of oxygen and nutrients from the blood into the cells and carbon dioxide and other waste products enter the blood from the cells.
- Blood is composed of red blood cells, white blood cells, platelets, and plasma. These components have different functions.

Respiratory System

- The main function of the respiratory system is to provide gas exchange between the blood and the air.
- When air is inhaled, the lungs remove oxygen from the air. Carbon dioxide is exhaled back into the environment.
- The main organs of the respiratory system are:
    1) Nose-Collects air from the environment. Moistens and heats the air before it enters the trachea.
    2) Trachea-The windpipe; moves air from the nose to the lungs.
    3) Bronchi (e.g. bronchus)-Tubes that move air from the trachea to the lungs; one bronchus leads to each lung; part of each bronchus is outside the lung and part is inside.
    4) Lungs-The main organs where gases are exchanged between air and the blood; the alveoli are small sacs within lung tissue. It is in the alveoli where the gas exchange takes place.
    5) Diaphragm-The muscle that aids in the breathing process and allows the rib cage to expand

Digestive System

- The main functions of the digestive system are to break down foods into nutrients that can be used by the body, absorb nutrients that are necessary for energy, growth, and maintenance, and rid the body of solid wastes.
- The organs of the digestive system can be divided into two categories, primary and secondary. Primary organs have a direct role in digesting food and come into physical contact with the food. Secondary organs support the process of digestion by secreting digestive juices. Food does not pass through secondary organs.
- The primary organs of the digestive system are:
    1) Mouth- Begins to break down food into smaller pieces through mechanical digestion; saliva in the mouth starts the process of chemical digestion.
    2) Esophagus- The transport tube that carries chewed food to the stomach.
    3) Stomach- Continues the process of mechanical digestion; and secretes gastric juices that continue the process of chemical digestion started in the mouth.
    4) Small intestines- The organ where most of the chemical digestion of food takes place; nutrients from food are also absorbed into the bloodstream through the small intestines.
    5) Large intestines- The organ where water from the food is absorbed into the bloodstream; prepares the remaining undigested food for elimination from the body.
    6) Rectum- A short tube that stores solid waste until it is eliminated from the body.
    7) Anus- Opening where solid waste is eliminated.
- The secondary organs of the digestive system are:
    8) Liver- Produces bile, which is used by the body to break up fat, and filters blood.
    9) Gallbladder- Stores bile produced by the liver.
    10) Pancreas- Produces digestive juices that help to further break down the food in the small intestine.

Excretory (Urinary) System

- The main function of the excretory system is to filter cellular wastes, toxins (chemicals that could be poisonous to the body), and excess water that result from cellular respiration.

- The main organs of the excretory (urinary) system are:
    1) Kidneys-The two kidneys get rid of urea, excess water, and some other waste materials released by the cells. These are eliminated as urine.
    2) Ureters-Tubes which connect each kidney to the bladder.
    3) Bladder-A saclike muscular organ which stores urine until it is released from the body.
    4) Urethra-Tube through which urine passes before it is removed from the body.

Nervous System

- The main functions of the nervous system are to receive stimuli from inside and outside the body, to interpret the stimuli, and initiate responses for survival.
- The main organs of the nervous system are:
    1) Brain- An organ which has three distinct parts that all serve to control and coordinate the activities of the body.
        - The cerebrum is the largest part of the brain. It controls thoughts, voluntary actions, and the sensations related to the five senses.
        - The cerebellum is the small lobe located at the back of the brain. It helps with balance and coordination.
        - The brain stem is located at the base of the brain and controls vital and involuntary processes (for example, breathing, the beating of the heart, and digestion).
    2) Spinal cord-A bundle of nerves that begins at the brainstem and continues down the center of the back through the vertebrae. It connects with the peripheral nerves.
    3) Peripheral nerves- A network of nerves that branch out from the spinal cord and connect to the rest of the body and transmit signals to and from the brain through the spinal cord.

Musculoskeletal System

- The main function of the musculoskeletal system is to provide movement and support for the body, to protect internal organs, and to provide attachment sites for the muscles.
- The main organs of the musculoskeletal system are:
    1) Muscles - soft tissue that has the ability to relax and contract in order to initiate movement within the body. There are three types of muscle:
        - Cardiac muscles - Involuntary muscle that forms the heart
        - Smooth muscles - Involuntary muscles that control many types of movement within the body (such as digestion).
        - Skeletal muscles - Voluntary muscles attached to bones and provide the force needed to move the bones; tendons connect the skeletal muscles to bones
    2) Bones - Provide shape and support for the body, protection for many organs and structures, and attachment sites for muscles.; some bones produce blood cells; some store minerals
    3) Joints- a place in the skeleton where two or more bones meet. There are many types of joints found in the body.
    4) Ligaments - soft connective tissue that attach bones at the joints.
    5) Tendons - soft connective tissue that attaches muscles to bones.

Relationships of the Major Body systems

- Even though each system in the human body performs its own function, the different systems work together and depend on one another for the body to function successfully.

Examples of relationships between the major body systems may be:

- All body systems are dependent upon the circulatory system to transport materials.
- The circulatory system works with the excretory system to help remove wastes from the body.
- The respiratory system works with the circulatory system to make sure that oxygen (O_2) reaches the bloodstream and carbon dioxide (CO_2) is removed from the bloodstream.
- The digestive system works with the circulatory system to make sure that nutrients made available by

digestion (for example glucose) get to the cells of the body.
- The nervous system works with the muscular and skeletal systems to direct behavior and movement.
- The nervous system controls internal processes in the body (for example digestion and circulation). Muscles control the movement of materials through some organs (for example the stomach, intestines, and the heart).

Extended Knowledge
To extend the student's knowledge, students may construct explanations to describe how damage and/or "malfunction" of one system can affect other body systems.
The student can explore how damage and/or malfunction of one system can affect other body systems. This would be an opportunity for students to research diseases such as cancer, diabetes, cardiovascular disease, obesity, or other relevant public health issues.
This is also an opportunity for teachers to clarify common misconceptions students have regarding the human body. For example, students often believe that blood is blue inside of the body until it comes in contact with the air. Teachers should help students to construct explanations as to why blood is always red, regardless of contact with the air.
Students can also obtain, evaluate, and communicate information regarding the other four systems not covered in this indicator (immune, endocrine, integumentary, and reproductive) and use this information to develop models that show how these systems interact with the other systems mentioned in this indicator.

NOTE: Caution should be taken when discussing the reproductive system with students. Follow guidelines as prescribed by the Health curriculum.

Science and Engineering Practices
S.1A.6

Standard 7.L.4 The student will demonstrate an understanding of how genetic information is transferred from parent to offspring and how environmental factors and the use of technologies influence the transfer of genetic information.

Conceptual Understanding
7.L.4A Conceptual Understanding: Inheritance is the key process causing similarities between parental organisms and their offspring. Organisms that reproduce sexually transfer genetic information (DNA) to their offspring. This transfer of genetic information through inheritance leads to greater similarity among individuals within a population than between populations. Technology allows humans to influence the transfer of genetic information.

Performance Indicator
7.L.4A.1 Obtain and communicate information about the relationship between genes and chromosomes to construct explanations of their relationship to inherited characteristics.

Assessment Guidance
The objective of this indicator is to *obtain and communicate information* about the relationship between genes and chromosomes to construct explanations of their relationship to inherited characteristics. Therefore, the primary focus of assessment should be for students to *obtain and communicate scientific information (from investigations and primary and secondary sources) to provide evidence to support the claim* that offspring have similar physical characteristics, or traits, as their parents because genetic information (DNA) is passed from

parent to offspring during sexual reproduction. This could include but is not limited to students obtaining information about the relationship between genes and chromosomes from age-appropriate references (science journals, relevant web resources, and other primary and secondary sources). Students reason with this information to construct an explanation for the role genes and chromosomes play in inherited characteristics and report their findings to their class.

In addition to *obtaining and communicating information*, students should *ask questions; plan and carry out investigations; analyze and interpret data; use mathematics and computational thinking; engage in argument from evidence; construct explanations; develop and use models*; and *construct devices or define solutions*.

Previous and Future Knowledge
H.B. 4 (Characteristics of Traits and Genes)

Essential Knowledge
It is essential for students to know that offspring may have the similar physical characteristics, or traits, as their parents because genetic information (DNA) is passed from parent to offspring during sexual reproduction.

- Each sex cell (egg or sperm) of the parent organism (plant or animal) contains one-half of the genetic material needed to create a new organism. Heredity is the passing of traits from one generation to another.

Chromosomes

- A structure found in the nucleus of a cell that contains the genetic information (DNA).
- DNA stands for deoxyribonucleic acid. DNA coils to form a double helix (spiral ladder shape)
- Chromosomes are composed of long strands of DNA.

Genes

- A segment of DNA found on a chromosome that contributes the inheritance of a particular trait.
- Genes are responsible for the inherited characteristics that distinguish one individual from another.
- Genes that contribute to a specific trait generally come in pairs.
- One gene from the pair is called an allele.
- Genes may be considered in two different ways:
    - Genotype—the set of genes carried by the organism.
    - Phenotype—the physical expression of the genes.

Extended Knowledge
To extend the student's knowledge, students may obtain and communicate information about the structure of DNA to construct explanations of DNA's relationship to inherited characteristics.

- DNA is composed of 4 nitrogenous base pairs (adenine, thymine, cytosine, and guanine) and a phosphorous and sugar backbone.
- In a DNA molecule, the adenine always pairs with the thymine and the cytosine always pairs with the guanine.
- RNA (ribonucleic acid) is a single strand of nitrogenous base pairs with a phosphorous and sugar backbone. RNA is used by the cell to aid the process of DNA transcription and translation.

To further understand genes and chromosomes and their relationship to inherited characteristics, students can develop and use models that explain the process of meiosis. In order to understand the process, the students can use mathematical and computational thinking to explain what happens with the number of chromosomes in the cells during the process of meiosis.

Science and Engineering Practices
S.1A.8

Standard 7.L.4 The student will demonstrate an understanding of how genetic information is transferred from parent to offspring and how environmental factors and the use of technologies influence the transfer of genetic information.

Conceptual Understanding
7.L.4A Conceptual Understanding: Inheritance is the key process causing similarities between parental organisms and their offspring. Organisms that reproduce sexually transfer genetic information (DNA) to their offspring. This transfer of genetic information through inheritance leads to greater similarity among individuals within a population than between populations. Technology allows humans to influence the transfer of genetic information.

Performance Indicator
7.L.4A.2 Construct explanations for how genetic information is transferred from parent to offspring in organisms that reproduce sexually.

Assessment Guidance
The objective of this indicator is to *construct explanations* for how genetic information is transferred from parent to offspring in organisms that reproduce sexually. Therefore, the primary focus of the assessment should be for students to *construct explanations of phenomena using (1) primary or secondary scientific evidence and models, (2) conclusions from scientific investigations, (3) predictions based on observations and measurements, or (4) data communicated in graphs, tables, or diagrams* demonstrating the process behind the passing of genetic information. This could include but is not limited to students recording data representing the frequency of certain inherited traits (tongue rolling, widow's peak, etc.) in their family. Students are encouraged to include as many generations as they can and to look at the frequency with which the traits are present.

In addition to *construct explanations,* students should *ask questions, plan and carry out investigations, analyze and interpret data, use mathematical and computational thinking, engage in argument from evidence, obtain, evaluate and communicate information, develop and use models,* and *construct devices or design solutions*.

Previous and Future Knowledge
H.B. 4 (Characteristics of Traits and Genes)

Essential Knowledge
It is essential for students to understand the process behind the passing of genetic information.
Inherited traits

- Characteristics that are passed from parent to offspring. Examples of inherited traits may be eye color, eye shape, hair type, or face shape.
- Some inherited traits are dominant and some are recessive.
    - Dominant trait—The version of a trait that will be expressed regardless of the other allele(s) that is(are) present.. Alleles for dominant traits are represented by capital letters.
    - Recessive trait—The version of a trait that will only be expressed if two recessive alleles are present. In the presence of a dominant trait, the recessive trait will not be expressed. Alleles for recessive traits are represented by lowercase letters.
- Depending on the parents, offspring can be homozygous or heterozygous for traits.
    - Homozygous means that the offspring either has two copies of the dominant allele (homozygous dominant) or two copies of the recessive allele (homozygous recessive).

- Heterozygous means that the offspring has one copy of the dominant allele (trait) and one copy of the recessive allele (trait).

NOTE TO TEACHER: It is NOT the intent of this indicate to focus on the process of meiosis.

Extended Knowledge
To extend the student's knowledge, students may construct explanations as to how the physical characteristics of organisms may be influenced by environmental factors. Examples of environmental factors that can alter the phenotype of an organism may be temperature, nutrients, injuries, disease, exposure to sun, or living conditions

Science and Engineering Practices
S.1A.6

Standard 7.L.4 The student will demonstrate an understanding of how genetic information is transferred from parent to offspring and how environmental factors and the use of technologies influence the transfer of genetic information.

Conceptual Understanding
7.L.4A Conceptual Understanding: Inheritance is the key process causing similarities between parental organisms and their offspring. Organisms that reproduce sexually transfer genetic information (DNA) to their offspring. This transfer of genetic information through inheritance leads to greater similarity among individuals within a population than between populations. Technology allows humans to influence the transfer of genetic information.

Performance Indicator
7.L.4A.3 Develop and use models (Punnett squares) to describe and predict patterns of the inheritance of single genetic traits from parent to offspring (including dominant and recessive traits, incomplete dominance, and co-dominance).

Assessment Guidance
The objective of this indicator is to *develop and use models* (Punnett squares) to describe and predict patterns of the inheritance of single genetic traits from parent to offspring (including dominant and recessive traits, incomplete dominance, and co-dominance). Therefore, the primary focus of assessment should be for students to *develop and use* Punnett squares to predict the ratio or percentage of the possible phenotypes and genotypes that will result from a genetic cross between two parents. This could include but is not limited to the development of Punnett squares for all types of monohybrid crosses. Students should also determine the most likely genotypes for parents based on the phenotypes of the offspring. Students should be able to use evidence to support their answer.

In addition to *developing and using models*, students should be asked to *ask questions; plan and carry out investigations; analyze and interpret data; use mathematics and computational thinking; engage in argument from evidence; construct explanations;* and *obtain, evaluate, and communicate information.*

Previous and Future Knowledge
H.B. 4 (Characteristics of Traits and Genes)

Essential Knowledge

It is essential for a student to use a Punnett square to predict the ratio or percentage of the possible genes that an offspring will have based on the genotype of the parents.

- In a Punnett square, the top of the table shows the alleles provided by one parent. The alleles for the other parent are placed along the left side of the table. One allele from each parent is placed in the individual squares, forming a new gene pair. The individual squares show the possibilities of allele pairs in the offspring.
- For example, the following table shows the cross Tt x tt:

	t	t
T	Tt	Tt
t	tt	tt

***Source - SC Science Academic Standards Support Document 2005*

- In this example, tallness (T) is the dominant trait and shortness (t) is the recessive trait. As the Punnett square shows, TT, Tt, and tt are all possible genotypes for the height of the offspring. The offspring with the genotypes TT and Tt will have a phenotype of tall; the offspring with the genotype of tt will have a phenotype of short.
- If the two alleles are the same (TT or tt), the genotype is considered homozygous. If the two alleles are different (Tt), the genotype is considered heterozygous (also referred to as *hybrid*).
- The example above shows the inheritance of a single characteristic (height in bean plants). A cross that shows the inheritance of a single characteristic is known as a monohybrid cross.
- It is difficult to predict most traits in humans (for example hair color or eye color) because there are multiple alleles that control these traits.

Incomplete Dominance

- Incomplete dominance is a condition when the dominant allele does not completely mask the recessive. As a result some of the recessive trait will be observed in the phenotype. An example of an incomplete dominance in plants may be color of flowers. The color red is dominant over the recessive color white. Pink flowers are a result of a blending of red and white.

Co-dominance

- Co-dominance is a condition when there is more than one dominant allele. As a result, both alleles will be expressed in the phenotype. An example of co-dominance in plants may be the color of the flowers. If both red and white alleles are dominant, both traits will be expressed in the flower. The AB blood type in humans is another example of co-dominance.

Extended Knowledge

Students frequently question the inheritance of human skin and eye color. Students can extend their knowledge by obtain, evaluate, and communicate information regarding polygenic inheritance. Polygenic inheritance is a condition when more than one gene controls the expression of a trait. For example, human skin color is controlled by multiple genes.

It is not essential for students to know how to complete a di-hybrid cross.

Science and Engineering Practices

S.1A.2

Standard 7.L.4 The student will demonstrate an understanding of how genetic information is transferred from parent to offspring and how environmental factors and the use of technologies influence the transfer of genetic information.

Conceptual Understanding
7.L.4A Conceptual Understanding: Inheritance is the key process causing similarities between parental organisms and their offspring. Organisms that reproduce sexually transfer genetic information (DNA) to their offspring. This transfer of genetic information through inheritance leads to greater similarity among individuals within a population than between populations. Technology allows humans to influence the transfer of genetic information.

Performance Indicator
7.L.4A.4 Use mathematical and computational thinking to predict the probability of phenotypes and genotypes based on patterns of inheritance.

Assessment Guidance
The objective of this indicator is to *use mathematical and computational thinking* to predict the probability of phenotypes and genotypes based on patterns of inheritance. Therefore the primary focus of assessment should be for students to *use mathematical and computational thinking to use grade-level appropriate statistics to analyze data* to predict the probability of phenotypes and genotypes based on patterns of inheritance. This could include but is not limited to making predictions regarding the genotype and phenotype of the offspring of a monohybrid cross. Students should be able to do this regardless of the genotype of the parents.

In addition to *using mathematical and computational thinking,* students should be *ask questions; plan and carry out investigations; analyze and interpret data; engage in argument from evidence; construct explanations; develop and use models;* and *obtain, evaluate and communicate information.*.

Previous and Future Knowledge
H.B. 4 (Characteristics of Traits and Genes)

Essential Knowledge
It is essential that students be able to use mathematical and computational thinking to determine a ratio of phenotypes and genotypes based on the results of a Punnett square (monohybrid cross).

- The ratios found after completion of the monohybrid cross should be converted into percentage.
- For example, in a cross of Tt and Tt, completing a Punnett square would look like:

	T	t
T	TT	Tt
t	Tt	tt

***Source - SC Science Academic Standards Support Document 2005*

- The results would yield TT, Tt, Tt, and tt. The phenotypic ratio in this case is 3:1 (where there are three dominant phenotypes and one recessive phenotype) and the genotypic ratio would be 1:2:1 (one homozygous dominant, two heterozygous, and one homozygous recessive).
- In this example, the phenotypic ratio can be converted into fractions, 75% dominant and 25% recessive. The genotypic ratio can be converted into fractions as 25% (one homozygous dominant), 50%(the two heterozygous genotypes), and 25% (one homozygous recessive genotype).

Extended Knowledge
Teachers may want to consider providing students with the following information:
In previous support documents the terms *hybrid* and *purebred* are used to refer to the genotype Tt and TT (or tt) respectively. Hybrid has been replaced with heterozygous and purebred has been replaced with homozygous. Students can analyze and interpret data in order to determine the genotypes and phenotypes of "family" members based on moving forward or backwards through a multi-generational "family tree".

Science and Engineering Practices
S.1A.5

Standard 7.L.4 The student will demonstrate an understanding of how genetic information is transferred from parent to offspring and how environmental factors and the use of technologies influence the transfer of genetic information.

Conceptual Understanding
7.L.4A Conceptual Understanding: Inheritance is the key process causing similarities between parental organisms and their offspring. Organisms that reproduce sexually transfer genetic information (DNA) to their offspring. This transfer of genetic information through inheritance leads to greater similarity among individuals within a population than between populations. Technology allows humans to influence the transfer of genetic information.

Performance Indicator
7.L.4A.5 Construct scientific arguments using evidence to support claims for how changes in genes (mutations) may have beneficial, harmful, or neutral effects on organisms.

Assessment Guidance
The objective of this indicator is to *construct scientific arguments using evidence* to support claims for how changes in genes (mutations) may have beneficial, harmful, or neutral effects on organisms. Therefore, the primary focus of assessment should be for students to *construct and analyze scientific arguments using information from a variety of sources (investigations and primary and secondary documents) to support claims* that genetic mutations can have a positive effect on an organism, a negative effect on the organism, or no effect on the organism at all. This could include but is not limited to investigating a specific genetic disorder that is the result of a genetic mutation. The student will list all possible factors about the genetic disorder. The student will create an argument as to whether the gene mutation has beneficial, harmful or neutral effects on the organism. This should lead to a class discussion related to the indicator.

In addition to *construct scientific arguments to support claims*, students should be asked to *ask questions; plan and carry out investigations; analyze and interpret data; use mathematics and computational thinking; construct explanations; obtain, evaluate and communicate information;* and *develop and use models.*

Previous and Future Knowledge
4.L.5A.4 (Inheritance and Environmental Factors, Traits)
H.B. 2 (Cell Systems)
H.B. 4 (Characteristics of Traits and Genes)

Essential Knowledge
It is essentials for students to understand what a genetic mutation is and to support a claim as to the mutation's impact on the organism The student's scientific argument must be supported by data or evidence.

- A mutation is any change in the genes of an organism. There are many causes for mutations. Many mutations occur randomly where others can be the result of some environmental exposure.
- Mutations can have a beneficial, harmful, or neutral effect on the organism.
- Some mutations could be classified as both beneficial and harmful.
- For example, the genetic disorder sickle cell anemia is harmful to the persons that have that disorder. However, the disorder arises from a mutation to protect humans from Malaria.
- Most mutations are automatically repaired by the organism's enzymes and therefore have no effect.
- When the mutation is not repaired, the resulting altered chromosome or gene structure is then passed to all subsequent daughter cells of the mutant cell, which may have adverse or beneficial effects on the cell, the organism, and future generations.
- If the mutant cell is a body cell (somatic cell), the daughter cells can be affected by the altered DNA, but the mutation will not be passed to the offspring of the organism.
- Body cell mutations can contribute to the aging process or the development of many types of cancer.
- If the mutant cell is a gamete (sex cell), the altered DNA will be transmitted to the embryo and may be passed to subsequent generations. Gamete cell mutations can result in genetic disorders.
- In some cases mutations are beneficial to organisms. Beneficial mutations are changes that may be useful to organisms in different or changing environments. These mutations result in phenotypes that are favored by natural selection and increase in a population

Teachers should allow the students to determine whether a mutation is beneficial, harmful, or neutral. Students should cite evidence from primary and secondary sources to support their arguments.

Extended Knowledge
To extend the student's knowledge, students can obtain, evaluate, and communicate information about the following:
Mutations are changes in the sequence of DNA and can occur in many ways. There are several types of mutations students may want to explore.

- Deletion - when DNA is removed or deleted. This can be as small as one base pair or as large as a section of chromosome.
- Insertions - when DNA is inserted into another section of DNA. As in a deletion, insertions can occur as a single base pair or large sections of chromosome.
- Frameshift - an insertion or deletion that is not in a multiple of three. This causes an entire shift of the reading frame and therefore the amino acid sequence is not properly assembled. This typically results in non-functional or dysfunctional proteins.
- Translocation - when large chunks of DNA is swapped between non-homologous chromosomes.
- There are other mutations that students many want to explore as well (point, silent, nonsense, missense).

From this information, students can construct explanations regarding how mutations can affect an organism as well as explain why only certain mutations are passed on to future generations.

Science and Engineering Practices
S.1A.7

Standard 7.L.4 The student will demonstrate an understanding of how genetic information is transferred from parent to offspring and how environmental factors and the use of technologies influence the transfer of genetic information.

Conceptual Understanding

7.L.4A Conceptual Understanding: Inheritance is the key process causing similarities between parental organisms and their offspring. Organisms that reproduce sexually transfer genetic information (DNA) to their offspring. This transfer of genetic information through inheritance leads to greater similarity among individuals within a population than between populations. Technology allows humans to influence the transfer of genetic information.

Performance Indicator

7.L.4A.6 Construct scientific arguments using evidence to support claims concerning the advantages and disadvantages of the use of technology (such as selective breeding, genetic engineering, or biomedical research) in influencing the transfer of genetic information.

Assessment Guidance

The objective of this indicator is to *construct scientific arguments using evidence* to support claims concerning the advantages and disadvantages of the use of technology (such as selective breeding, genetic engineering, or biomedical research) in influencing the transfer of genetic information. Therefore, the primary focus of assessment should be for students to *construct scientific arguments from evidence to support claims* that there are advantages and disadvantages in using technology to influence genetic traits. This could include but is not limited to students researching methods used to influence genetic traits and cite evidence to show the advantages and disadvantages of using these methods. Using these concepts, the students should be able to cite primary and secondary sources that determine the benefits and disadvantages of modifying the genome of organisms

In addition to *construct scientific arguments to support claims*, students should be asked to *ask questions; plan and carry out investigations; analyze and interpret data; use mathematics and computational thinking; construct explanations; obtain, evaluate and communicate information; develop and use models*; and *construct devices or define solutions.*

Previous and Future Knowledge

H.B. 2 (Cell Systems)
H.B. 4 (Characteristics of Traits and Genes)

Essential Knowledge

It is essential for students to understand the advantages and disadvantages of the use of technology in influencing the transfer of genetic information.

- Humans have long used a variety of methods to alter and reinforce certain traits in living things.
- Genetic engineering is the manipulation of an organism's genes (genome). There are many types of genetic engineering.
- Selective breeding is a type of genetic engineering. It is a process humans use to breed or reinforce desired traits into a particular organism. For example, one of the oldest examples of selective breeding is the diversity within dogs. The dog as a species has changed dramatically from its wolf ancestors due to selective breeding. Humans have used selective breeding to reinforce certain desired traits within dog breeds such as herding behaviors or body shape.
- Technology can also be used to add, or modify genes directly in the genome of living things. These genetically modified organisms can be used in food or in other commercial applications. For example, resistance to plant diseases can be added to corn's genome so the plant is not affected by these diseases.

- Biomedical research is another aspect of technology and genetics. Biomedical research employs a variety of techniques to advance medical science and improve human lives. For example, the human genome project has mapped the entire human genome. This information can be used to inform individuals during genetic counselling and when making health decisions.

Extended Knowledge
Students can research examples of biomedical research and construct scientific arguments using evidence to support claims concerning the advantages and disadvantages of utilizing stem cells or genetically modified organisms (GMOs).

Science and Engineering Practices
S.1A.7

Standard 7.EC.5 The student will demonstrate an understanding of how organisms interact with and respond to the biotic and abiotic components of their environments.

Conceptual Understanding
7.EC.5A In all ecosystems, organisms and populations of organisms depend on their environmental interactions with other living things (biotic factors) and with physical (abiotic) factors (such as light, temperature, water, or soil quality). Disruptions to any component of an ecosystem can lead to shifts in its diversity and abundance of populations.

Performance Indicator
7.EC.5A.1 Develop and use models to describe the characteristics of the levels of organization within ecosystems (including species, populations, communities, ecosystems, and biomes).

Assessment Guidance
The objective of this indicator is to *develop and use models* to describe the characteristics of the levels of organization within ecosystems. Therefore, the primary focus of assessment should be for students to *construct drawings/diagrams and models that represent* the levels of organization within the environment. This could include but is not limited to students researching information about and making a model ecosystem to describe the levels of organization within a natural environment, including biotic and abiotic factors. .

In addition to *develop and use models*, students should be asked to *ask questions; plan and carry out investigations; analyze and interpret data; use mathematics and computational thinking; engage in argument from evidence; construct explanations; obtain, evaluate, and communicate information;* and *construct devices or define solutions*

Previous and Future Knowledge
5.L.4A (Ecosystems)
5.L.4B (Survival Needs of Organisms)
6.L.4 (Classification of Organisms)
H.B.6 (Ecosystems)

Essential Knowledge
It is essential for students to know the levels of organization within the environment.

The organization in the natural environment from most simple to most complex includes the species (individual organisms), populations, communities, ecosystems, and biomes. Each level is defined by the type and number of biotic (organisms) and/or the abiotic (non-living) factors present.

Species:

- The individual living organism
- Organisms of the same species can reproduce to make more of that species
- Example – white tail deer

Populations

- All of the individuals of a given species in a specific area or region at a certain time.
- Members of a population compete for food, water, space, and mates.
- Example – all of the white tail deer in South Carolina

Communities

- All the different populations in a specific area or region at a certain time.
- Communities involve many types of interactions among the populations.
- Some of these interactions involve the obtaining and use of food, space, or other environmental resources.
- Example – all of the living organisms (biotic factors) in the environment with the white tail deer, including pine trees, grass, squirrels, moss, mushrooms, and Carolina wrens.

Ecosystems

- One or more communities in an area and the abiotic factors, including water, sunlight, oxygen, temperature, and soil is an ecosystem.
- Example – all of the living organisms (biotic factors) in the environment with the white tail deer, including pine trees, grass, squirrels, moss, mushrooms, and Carolina wrens as well as all of the abiotic (non-living) factors such as rivers, soil, air, and rocks

Biomes

- Individual ecosystems grouped together according to the climate, the predominant vegetation, and characterized by adaptations of organisms to that particular environment.
- Example – the temperate deciduous forest that the white tail deer lives in.

Extended Knowledge

Within an ecosystem, organisms have specific places where their needs are met and specific roles within the ecosystem.

- The place where an organism lives in order to obtain its food, water, shelter and other things needed for survival is called its habitat.
- The particular role of an organism in its environment including type of food it eats, how it obtains its food and how it interacts with other organisms is called its niche. For example, the niche of a bee is to pollinate flowers as it gathers nectar for its food.

Students can design and use models to demonstrate how the various organisms in a particular ecosystem interact. These models can help the students to analyze data and predict what effect changes will have on an environment (see subsequent indicators).

Science and Engineering Practices

S.1A.2

Standard 7.EC.5 The student will demonstrate an understanding of how organisms interact with and respond to the biotic and abiotic components of their environments.

Conceptual Understanding
7.EC.5A In all ecosystems, organisms and populations of organisms depend on their environmental interactions with other living things (biotic factors) and with physical (abiotic) factors (such as light, temperature, water, or soil quality). Disruptions to any component of an ecosystem can lead to shifts in its diversity and abundance of populations.

Performance Indicator
7.EC.5A.2 Construct explanations of how soil quality (including composition, texture, particle size, permeability, and pH) affects the characteristics of an ecosystem using evidence from soil profiles.

Assessment Guidance
The objective of this indicator is to *construct explanations* of how soil quality (including composition, texture, particle size, permeability, and pH) affects the characteristics of an ecosystem using evidence from soil profiles. Therefore, the primary focus of assessment should be for students to *construct explanations from investigations, primary and secondary resources, and data communicated in graphs, tables, or diagrams to support claims* that the soil is one of the most valuable abiotic factors in an ecosystem. This could include but is not limited to students performing soil analysis activities. The students will observe and analyze soil composition, texture, particle size, permeability, and pH to explain how these factors affect the types of organisms found in a specific area.

In addition to *construct explanations*, students should be asked to *ask questions; plan and carry out investigations; engage in argument from evidence; obtain, evaluate and communicate information; develop and use models;* and *construct devices or design solutions.*

Previous and Future Knowledge
H.B.6 (Ecosystems)

Essential Knowledge
It is essential for students to know that soil is one of the most valuable abiotic factors in an ecosystem.

- Soil has an effect on the types of plants that can grow in an ecosystem, which directly impacts the types of other organisms that can survive there.
- If a change in the properties of soil occurs, the ecosystem (including biotic and abiotic factors) will also change.

Soil quality is based on properties that can be observed such as soil profile, composition, texture, or particle size.
Soil profile

- Soils form in layers, or horizons, and all the layers make up the soil profile.
- A mature soil profile consists of three layers – topsoil, subsoil, and parent material above bedrock.
- Topsoil that is nutrient rich, containing a mixture of humus, clay, and minerals, is most suitable for plant growth.
- Most animals live in the topsoil horizon.

Composition

- Soil is a mixture of rock particles, minerals, decayed organic material, air, and water.
- The decayed organic matter in soil is humus.
- The sand, silt, and clay portion of soil comes from weathered bedrock material.

- The combination of these materials in soil determines the soil type and affects the types of plants that can grow in it or animals that can live in it.
- Factors that may affect soil type are the types of plants, climate, time, and slope of the land.

Texture

- Soil texture depends on the size of individual soil particles and is determined by the relative proportions of particle sizes that make up the soil.
- Texture names may include loam, sandy clay loam, silt loam, or clay depending upon the percent of sand, silt, and clay in the soil sample.
- The texture affects the amount of water that can be absorbed for use by plants and animals.

Particle size

- Soil particles are classified by size ranging from coarse sand to very fine sand to silt, and finally to the smallest particle, clay.
- Soil particles that are larger than 2mm are called gravel.
- Particle size also affects the amount of water that can be absorbed and used by plants and animals.

Soil quality is also based on properties that can be measured, such as permeability and pH.

Permeability

- Soil particles have open spaces (pores) between them that let water flow through.
- How freely that water flows is the permeability of the soil.
- The closer the particles pack together because of particle size, the less permeable the soil is.
- Measuring permeability involves calculating the rate of drainage.

pH

- Soils can be basic or acidic and usually measure 4-10 on the pH scale.
- Indicators can be used to measure the pH of soils.
- Most plants grow best in soils with a pH of between 5 and 7.
- Regardless of the nutrients present in the soil, if the pH is not suitable those nutrients will be inaccessible to the organisms.
- Lime is a kind of fertilizer that alters pH and making the soil nutrients more accessible.

Extended Knowledge

Students should construct explanations of how changing the soil quality (including composition, texture, particle size, permeability, and pH) in specific ecosystems will affect the characteristics of that ecosystem. The students should be able to analyze and interpret data from soil profiles as evidence to support their scientific argument.

Science and Engineering Practices

S.1A.6

Standard 7.EC.5 The student will demonstrate an understanding of how organisms interact with and respond to the biotic and abiotic components of their environments.

Conceptual Understanding

7.EC.5A In all ecosystems, organisms and populations of organisms depend on their environmental interactions with other living things (biotic factors) and with physical (abiotic) factors (such as light, temperature, water, or soil quality). Disruptions to any component of an ecosystem can lead to shifts in its diversity and abundance of populations.

Performance Indicator
7.EC.5A.3 Analyze and interpret data to predict changes in the number of organisms within a population when certain changes occur to the physical environment (such as changes due to natural hazards or limiting factors).

Assessment Guidance
The objective of this indicator is to *analyze and interpret data* to predict changes in the number of organisms within a population when certain changes occur to the physical environment. Therefore, the primary focus of assessment should be for students to *analyze and interpret data from informational texts, observations, measurements, or investigations using a range of methods (such as tabulation, graphing, or statistical analysis) to support claims* that changes in the physical environment can cause changes in the size of a population. This could include but is not limited to students analyzing and interpreting data from an environmental case study or simulation that demonstrates the cause and effect relationship between environmental changes and populations of organisms within an ecosystem. Students should be able to predict how natural hazards and limiting factors will affect the population of any given species and be able to use data to support their conclusions.

In addition to *analyze and interpret data*, students should be asked to *ask questions; plan and carry out investigations; use mathematics and computational thinking; engage in argument from evidence; construct explanations; develop and use models; obtain, evaluate, and communicate information;* and *construct devices or define solutions.*

Previous and Future Knowledge
5.L.4A.1 (Ecosystems)
5.L.4B.4 (Balance of nature, limiting factors)
H.B.6 (Ecosystems)

Essential Knowledge
It is essential for students to know that there are various factors that can change the environment. These factors, which include natural hazards and limiting factors, all have similar effects on the environment, and can affect each other. These changes can have an effect on the amount of resources available in the environment. This can lead to competition for food, water, space, or shelter.
Natural Hazards
- A natural hazard can be defined as any naturally occurring event that has an effect on the ecosystem. Examples include but are not limited to floods, hurricanes, and wildfires.
- All of these events can cause significant changes to the local environment that will make it more difficult for some organisms to survive where others flourish in the changed environment.
- For example, the heat and smoke generated during a wildfire can influence seed germination in some plant species.

Limiting Factors
- A limiting factor is anything that prevents a population from growing larger.
- The maximum number of organisms that can survive in a particular ecosystem is known as the carrying capacity.
- Limiting factors can be biotic (food and predators) and/or abiotic (soil quality and water supply).

Climate
- Climate refers to the temperature and amount of rainfall in a particular environment.
- Changes in temperature and the amount of rainfall from what is normal for that area can change an environment, which will have an effect on the populations in the area.

Availability of resources
- Organisms require a certain amount of food water, space, and shelter in order to survive and reproduce.

- When the availability of the amount of any of these resources in a given area is less than what the various populations need, it becomes a limiting factor.
- When plants and animals compete for these resources, some will get them and some will not.
- Those that get the resources survive. Those that do not, will move to where the resources are available or die.

Extended Knowledge
Students can analyze and interpret data from scenarios that describe a change to a population (due to natural hazards or limiting factors) and then make predictions regarding the changes that the environment, and the organisms within that environment, will experience.

Science and Engineering Practices
S.1A.2

Standard 7.EC.5 The student will demonstrate an understanding of how organisms interact with and respond to the biotic and abiotic components of their environments.

Conceptual Understanding
7.EC.5B Organisms in all ecosystems interact with and depend upon each other. Organisms with similar needs compete for limited resources. Food webs and energy pyramids are models that demonstrate how energy is transferred within an ecosystem.

Performance Indicator
7.EC.5B.1 Develop and use models to explain how organisms interact in a competitive or mutually beneficial relationship for food, shelter, or space (including competition, mutualism, commensalism, parasitism, and predator-prey relationships).

Assessment Guidance
The objective of this indicator is to *develop and use models* to explain how organisms interact in a competitive or mutually beneficial relationship for food, shelter, or space. Therefore, the primary focus of assessment should be for students to *construct drawings/diagrams and models that represent or use simulations to investigate* the complex interactions between organisms in the environment. This could include but is not limited to students constructing a food chain or food web in a particular ecosystem and researching the types of symbiotic relationships that occur within an ecosystem to construct a model that depicts the interrelationships between organisms

In addition to *develop and use models*, students should be asked to *ask questions; plan and carry out investigations; analyze and interpret data; use mathematics and computational thinking; engage in argument from evidence; construct explanations; obtain, evaluate, and communicate information;* and *construct devices or define solutions*

Previous and Future Knowledge
5.L.4B.2 (Food Chain, Energy, Food Web)
5.L.4B.3 (Predator, Prey, Parasite, Host)
6.L.4 (Classification of Organisms)
H.B.6 (Ecosystems)

Essential Knowledge

It is essential for students to understand the complex interactions between organisms in the environment.

- In any given ecosystem, organisms have interactions that allow them greater access to resources. These interactions can lead to competition for resources.
- Consequently, relationships form that allow a greater number of species access to those resources. We call these relationships symbiotic relationships.
- Examples include competition, mutualism, commensalism, and parasitism.

Competition

- Competition is a relationship that occurs when two or more organisms need the same resource at the same time.
- Competition can be among the members of the same or different species and usually occurs with organisms that share the same niche.
- An ecological *niche* refers to the role of an organism in its environment including type of food it eats, how it obtains its food and how it interacts with other organisms.
- Two species with identical ecological niches cannot coexist in the same habitat. Competition usually results in a decrease in the population of a species less adapted to compete for a particular resource.

Symbiosis

- A symbiotic relationship exists between organisms of two different species that live together in direct contact. The balance of the ecosystem is adapted to the symbiotic relationship.
- If the population of one or other of the symbiotic organisms becomes unbalanced, the populations of both organisms will fluctuate in an uncharacteristic manner. Symbiotic relationships include parasitism, mutualism, and commensalism.

Parasitism

- Parasitism is a symbiotic relationship in which one organism (the parasite) benefits at the expense of the other organism (the host). In general, the parasite does not kill the host.
- Some parasites live within the host, such as tape worms, heartworms, or bacteria. Some parasites feed on the external surface of a host, such as aphids, fleas, or mistletoe.
- The parasite-host populations that have survived have been those where neither has a devastating effect on the other.
- Parasitism that results in the rapid death of the host is devastating to both the parasite and the host populations.
- It is important that the host survive and thrive long enough for the parasite to reproduce and spread.

Mutualism

- Mutualism is a symbiotic relationship in which both organisms benefit. Because the two organisms work closely together, they help each other survive.
- For example, bacteria, which have the ability to digest wood, live within the digestive tracts of termites; plant roots provide food for fungi that break down nutrients the plant needs.

Commensalism

- Commensalism is a symbiotic relationship in which one organism benefits and the organism is not affected.
- For example, barnacles that attach to whales are dispersed to different environments where they can obtain food and reproduce; burdock seeds that attach to organisms and are carried to locations where they can germinate.

Predator- Prey Relationships

- *Predation* is an interaction between species in which one species (the predator) hunts, kills, and eats the other (prey). This interaction helps regulate the population within an ecosystem thereby causing it to become stable.

- Fluctuations in predator–prey populations are predictable. At some point the prey population grows so numerous that they are easy to find.

A graph of predator–prey density over time shows how the cycle of fluctuations results in a stable ecosystem.

- As the prey population increases, the predator population increases.
- As the predator population increases, the prey population decreases.

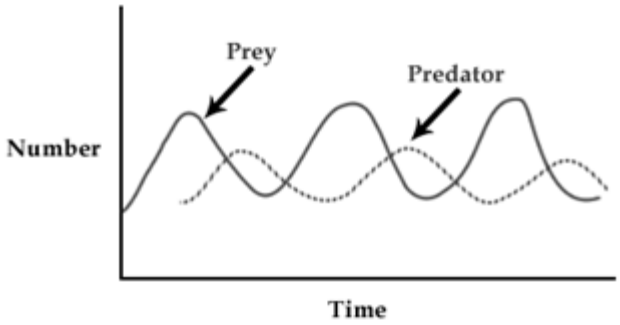


Image Source: SC Science Academic Standards Support Document 2005

Extended Knowledge

The student can analyze and interpret data (from primary sources or from simulations) as evidence to support their predictions regarding how changes to one organism will affect another organism in the community. The student can also obtain, evaluate, and communicate information regarding how human actions (large scale effects such as global climate and/or smaller scale effects such as building a highway) will affect population size.

Science and Engineering Practices

S.1A.2

Standard 7.EC.5 The student will demonstrate an understanding of how organisms interact with and respond to the biotic and abiotic components of their environments.

Conceptual Understanding

7.EC.5B Organisms in all ecosystems interact with and depend upon each other. Organisms with similar needs compete for limited resources. Food webs and energy pyramids are models that demonstrate how energy is transferred within an ecosystem.

Performance Indicator

7.EC.5B.2 Develop and use models (food webs and energy pyramids) to exemplify how the transfer of energy in an ecosystem supports the concept that energy is conserved.

Assessment Guidance

The objective of this indicator is to *develop and use models* (food webs and energy pyramids) to exemplify how the transfer of energy in an ecosystem supports the concept that energy is conserved. Therefore, the primary focus of assessment should be for students to *construct drawings/diagrams and models that represent or use simulations to investigate* the energy roles that organisms have in their environments. This could include but is not limited to students develop and use a model of a food chain or food web. This model must show the flow of energy within the ecosystem.

In addition to *develop and use models*, students should be asked to *ask questions; plan and carry out investigations; analyze and interpret data; use mathematics and computational thinking; engage in argument from evidence; construct explanations; obtain, evaluate, and communicate information;* and *construct devices or define solutions*

Previous and Future Knowledge
5.L.4A. (Ecosystems)
5.L.4B.2 (Food Chain, Energy, Food Web)
H.B.6 (Ecosystems)

Essential Knowledge
It is essential for students to know organisms have energy roles in their environments. Each role is determined by how the organism obtains its energy and how they interact with other organisms in the environment.
The flow of energy in an environment can be represented using the following diagrams:
Food webs

- A food web describes the organisms in a particular ecosystem found in interconnecting food chains using pictures or words and arrows.
- Food webs describe the complex patterns of energy flow in an ecosystem by modeling who consumes whom or what.

Energy pyramids

- An energy pyramid is a graphical representation of the energy flow in an ecosystem.
- The amount of energy that moves from one trophic level to another in an energy pyramid is not the same.
- Energy availability decreases as it moves up the energy pyramid. The most energy is available at the producer level of the pyramid.

Extended Knowledge
With regard to energy flow with in an ecosystem, the sun produces 100% of the energy but only 10% is used by producers during photosynthesis. The other 90% is lost to heat in the environment. At each trophic level, only 10% of available energy from the previous level is transferred. Students should use mathematical and computational thinking to demonstrate how energy moves through an ecosystem as well as predict what will happen to the ecosystem if various organisms are lost (through any of the other means mentioned in this standard).

Science and Engineering Practices
S.1A.2

Standard 7.EC.5 The student will demonstrate an understanding of how organisms interact with and respond to the biotic and abiotic components of their environments.

Conceptual Understanding
7.EC.5B Organisms in all ecosystems interact with and depend upon each other. Organisms with similar needs compete for limited resources. Food webs and energy pyramids are models that demonstrate how energy is transferred within an ecosystem.

Performance Indicator
7.EC.5B.3 Analyze and interpret data to predict how changes in the number of organisms of one species affects the balance of an ecosystem.

Assessment Guidance
The objective of this indicator is to *analyze and interpret data* to predict how changes in the number of organisms of one species affect the balance of an ecosystem. Therefore, the primary focus of assessment should be for students to *analyze and interpret data from informational texts, observations, measurements, simulations, or investigations using a range of methods (such as tabulation, graphing, or statistical analysis) to predict* how changes in the environment can occur due to changes in populations. This could include but is not limited to case studies of large, dramatic decreases in populations of organisms. Students could research examples of large population decreases, such as unexplained colony collapse of honeybees or bats affected by White Nose Syndrome. Using that research students could construct graphs or other methods of statistical analysis to look for patterns in the data. Using the data, students could construct a claim as to the overall effect on the balance of the ecosystem affected by rapid changes in population size.

In addition to *analyze and interpret data*, students should be asked to *ask questions; plan and carry out investigations; use mathematics and computational thinking; engage in argument from evidence; construct explanations; develop and use models; obtain, evaluate, and communicate information;* and *construct devices or define solutions.*

Previous and Future Knowledge
5.L.4A.1 (Ecosystems)
5.L.4B.4 (Balance of Nature, Limiting Factor)
H..B.6 (Ecosystems)

Essential Knowledge
It is essential for the student to know that changes in the environment can occur due to changes in populations. Changes in populations can occur when new members enter a population or when members leave a population. This will have an effect on the population density (the number of organisms in the given amount of space) for a particular area.
Births and Deaths
- New births are the main way that organisms are added to a population.
- The number of births in a population during a certain amount of time is called the birth rate.
- Deaths are the main way that organisms leave a population.
- The number of deaths in a population during a certain amount of time is called the death rate.

Immigration & Emigration
- The size of the population can change when members move into or out of the population.
- Immigration is when organisms move in from another environment.
- When part of the population leaves the environment, this is known as emigration.

The natural slowing of population growth as it nears Earth's carrying capacity is due to an increase in the death rate and a decrease in the birth rate as a result of:
- Food and water shortages
- Pollution of the environment
- Spread of diseases

An increasing population can have an effect on the amount of available clean water.
- If clean water is being depleted at a greater rate than it can be purified, it is not considered renewable in our lifetime.

An increasing population can have an effect on the amount of waste that is produced.

- Although there are mechanisms in place to control the disposal of some waste products, more waste is produced than can be managed effectively.
- Some waste products require complicated and costly means for removal once they are introduced into the environment.

The goal of this indicator is for students to analyze data. As a result, teachers should provide charts, diagrams, and other visual representations so that students can predict how changes in populations affect the ecosystem.

Extended Knowledge

The student can analyze and interpret data (from primary sources or from simulations) to predict how changes to one organism will affect another organism in the community. The student can also analyze and interpret data to explore how human actions (large scale effects such as global climate and/or smaller scale effects such as building a highway).

Science and Engineering Practices

S.1.A.4

Standard 7.EC.5 The student will demonstrate an understanding of how organisms interact with and respond to the biotic and abiotic components of their environments.

Conceptual Understanding

7.EC.5B Organisms in all ecosystems interact with and depend upon each other. Organisms with similar needs compete for limited resources. Food webs and energy pyramids are models that demonstrate how energy is transferred within an ecosystem.

Performance Indicator

7.EC.5B.4 Define problems caused by the introduction of a new species in an environment and design devices or solutions to minimize the impact(s) to the balance of an ecosystem.

Assessment Guidance

The objective of this indicator is to *define problems* caused by the introduction of a new species in an environment and design devices or solutions to minimize the impact(s) to the balance of an ecosystem. Therefore, the primary focus of assessment should be for students to *construct devices or design solutions using scientific knowledge to solve specific problems or needs: (1) ask questions to identify problems or needs, (2) ask questions about the criteria and constraints of the device or solutions, (3) generate and communicate ideas for possible devices or solutions, (4) build and test devices or solutions, (5) determine if the devices or solutions solved the problem and refine the design if needed, and (6) communicate the results* that demonstrate that students understand the impact the introduction of a new species has on the ecosystem. This could include but is not limited to case studies of invasive species introduced to new ecosystems. Kudzu, coyotes, the zebra mussel, cane toad, and burmese python are all well documented modern examples of invasive species. Students could analyze statistics of native species before and after introduction of invasive organisms. Using data, students could construct graphs to show patterns. Once patterns have been established, students could devise methods to reduce the environmental impact). Students could communicate their results in a variety of ways such as public service announcements, OpEd pieces, or community action projects.

In addition to *define problems* and *design possible solutions,* students should be asked to *develop and use models; plan and carry out tests; analyze and interpret data; use mathematics and computational thinking; engage in argument from evidence*; and *obtain, evaluate, and communicate information.*

Previous and Future Knowledge
5.L.4A.1 (Ecosystems)
5.L.4B.3 (Predator, Prey, Parasite, Host)
5.L.4B.4 (Balance of Nature, Limiting Factor)
H.B.6 (Ecosystems)

Essential Knowledge
It is essential for students to understand the impact the introduction of a new species to an existing environment has on the ecosystem.
Any time a non-native species is introduced to a new environment, whether accidentally or purposely, there are consequences to that introduction. When there is a negative impact on the environment, we refer to these organisms as *invasive species*.
Invasive Species

- Invasive species can have a major impact on the ecosystem.
- They can change an entire habitat by occupying the same niche as native species. That in turn causes unnatural competition among organisms. Environmental pressure then increases as the carrying capacity of the ecosystem is reached.
- Native species that are beneficial to the environment can be crowded out or replaced by the invasive species.
- There are many well-known examples of invasive species.
    - The zebra mussel and its effect on the aquatic marine ecosystems of the great lakes are well documented.
    - Another example is the red fire ant of South America that has infiltrated the southeastern US and continues to spread.

Most governments have programs and regulations that prevent and manage invasive species. Prevention is the first line of defense against invasive species. If preventive methods fail, then a quick response will help reduce the impact on the environment. There are three ways human can respond to invasive species.

- Physical Control - this would entail erecting barriers to prevent new species from entering new environments. This can also include physical removal of new species.
- Chemical Control - applying poisons (pesticides or herbicides) to eliminate new species.
- Biological Control - uses living organisms to reduce or completely eliminate the invasive species. In some cases the control organism will prey on the invasive species or in other cases the control organism causes disease in the target species.

Extended Knowledge
Not all non-native species are invasive. Many species have a neutral or beneficial effect on the environment. There are pros and cons to using control methods with invasive species. Many are considered controversial, doing more harm than good. Students can analyze and interpret data in order to engage in scientific argumentation regarding the various control methods. Students can also use this data to design devices or solutions to minimize the impact(s) of a certain species.

Science and Engineering Practices
S.1.B.1